*Table 3-38. Sampling and Data Evaluation Protocols at Pre-Discharge Monitoring Locations*

| Location Code | Location Description | Sample Types/ Frequencies | Analytes | Data Evaluation |
|---|---|---|---|---|
| A4 POND | Pond A-4 at east end of pond near outlet works | Prior to discharge | Pu, Am, isotopic U[a], nitrate | Consultation with regulators prior to discharge |
| B5 POND | Pond B-5 at east end of pond near outlet works | Prior to discharge | Pu, Am, isotopic U, nitrate | Consultation with regulators prior to discharge |
| C2 POND | Pond C-2 at east end of pond near outlet works | Prior to discharge | Pu, Am, isotopic U | Consultation with regulators prior to discharge |

Notes: [a]Isotopes U-233,234; U-235; U-238.
Nitrate is analyzed as nitrate+nitrite; the nitrate+nitrite result is conservatively compared to the nitrate standard only.

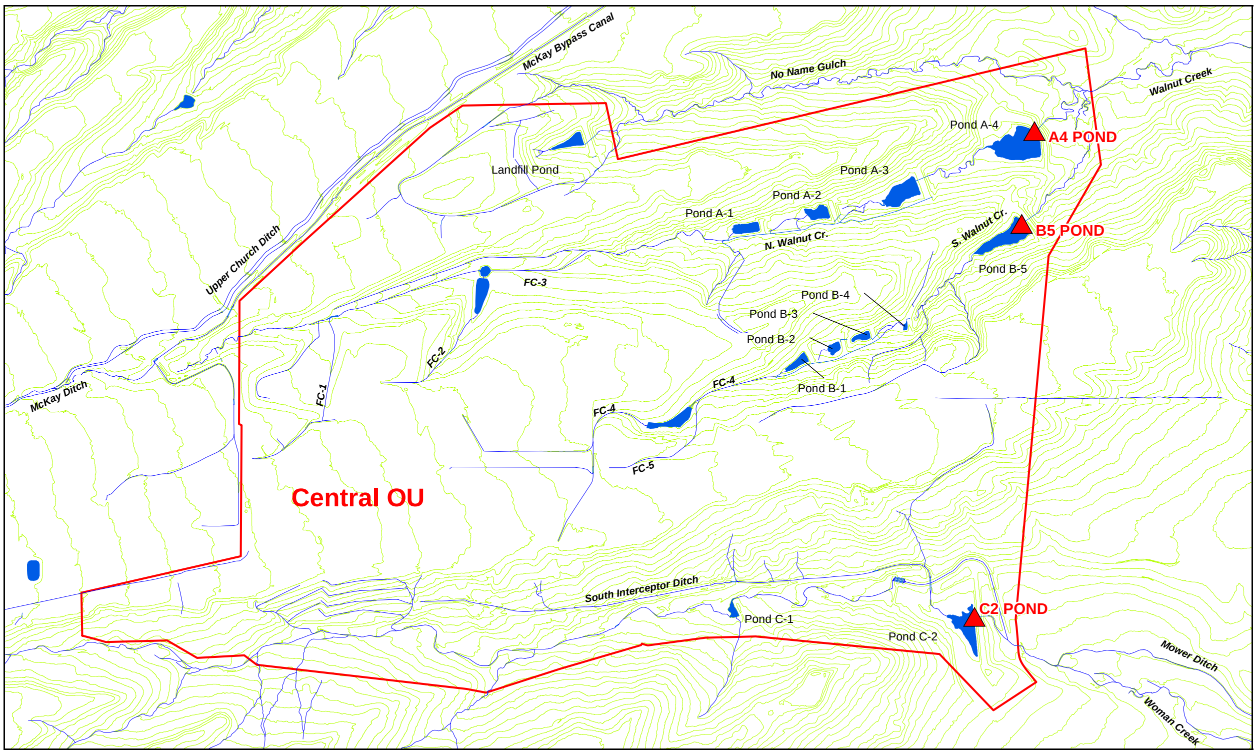



*Figure 3-43. Pre-Discharge Sampling Locations*

### *Data Evaluation*

During CY 2007, pre-discharge samples were collected at Ponds A-4 and B-5. All data suggested, and was subsequently confirmed by POC sampling (see Section 3.1.2.1), that the planned discharges would not result in reportable compliance values at the downstream POCs.

## 3.1.3 Rocky Flats Hydrology

The following section provides information for all automated surface-water monitoring and precipitation gage locations at the Site that operated during CY 2007. For locations with continuous flow measurement, graphical discharge summaries are provided. Graphical summaries are also provided for all precipitation gage locations. Numerical discharge and precipitation values are included in the tables in Appendix A.

Groundwater hydrology is also addressed. This includes a discussion of groundwater levels in various areas of interest via the preparation of hydrographs and potentiometric surface maps. Flow velocities are also calculated. Hydrographs for monitoring wells are included in Appendix A.4.

#### 3.1.3.1 General Hydrologic Setting

Streams and seeps at the Site are largely ephemeral, with stream reaches gaining or losing flow, depending on the season and precipitation amounts. Surface-water flow across the Site is primarily from west to east, with three major drainages traversing the Site. Fourteen ponds (plus several small stock ponds) collect surface-water runoff, although only 12 ponds are within the COU and maintained by DOE-LM. The Site drainages and ponds, including their respective pertinence to this report, are described below and shown on Figure 3-44.

The major stream drainages leading out of the Refuge, from north to south, are Rock Creek, Walnut Creek, and Woman Creek. North Walnut Creek flows through the A-Series Ponds and South Walnut Creek flows through the B-Series Ponds; both are tributaries to Walnut Creek. The hydrologic routing diagram (as of December 31, 2007) for the locations included in this report is shown on Figure 3-45.

The groundwater hydrology is generally characterized by relatively thin, shallow saturated materials (in the COU, typically on the order of a few dozen feet thick and less than 50 feet deep). This shallow saturated interval occurs within the unconsolidated Rocky Flats Alluvium, hillslope colluvium, valley-fill alluvium, artificial fill, and the weathered portion of the underlying bedrock. Collectively, these materials are referred to as the upper hydrostratigraphic unit (UHSU). Regionally, groundwater flows from west to east within the UHSU of the pediment surfaces, except where locally diverted toward generally east-west trending drainages that bisect these pediments. Groundwater typically discharges at seeps and springs along pediment edges, or as baseflow to surface water. Vertical flow is sharply limited by the low-permeability claystones underlying the unconsolidated surficial materials. This underlying low-permeability bedrock surface comprises the Arapahoe and Laramie Formations, which are typically undifferentiated; the gentle eastward dip of the unconformity marking the contact between this bedrock and the overlying unconsolidated surficial materials acts to direct the groundwater flow. Locally, this bedrock may include sandstone lenses that subcrop or are sufficiently shallow to be included in the UHSU. For a more thorough description of the hydrogeology at Rocky Flats, refer to EG&G (1995a).

***Surface Water***

**Walnut Creek**

Walnut Creek receives surface-water flow from the central third of the Refuge, including the majority of the COU. It consists of several tributaries: McKay Ditch, No Name Gulch, North Walnut Creek, and South Walnut Creek. These tributaries join Walnut Creek upstream of the Refuge’s eastern boundary (Indiana Street). East of Indiana Street, Walnut Creek flows through a diversion structure normally configured to divert flow to the Broomfield Diversion Ditch around

Great Western Reservoir and into Big Dry Creek. The Walnut Creek tributaries, from north to south, are described below.

### McKay Ditch

The McKay Ditch was formerly a tributary to Walnut Creek within the Refuge boundary, but was diverted in July 1999 into a new pipeline to keep McKay Ditch water from commingling with water in Walnut Creek upstream of Indiana Street. Although no longer a contributor to Walnut Creek, the McKay Ditch drainage is described here to clarify water routing. The new configuration allows the City of Broomfield to direct water from the South Boulder Diversion Canal, across the northern portion of the Refuge and directly into Great Western Reservoir, without entering Walnut Creek. This configuration prevents the commingling of McKay Ditch water with discharged water from the Site ponds. McKay Ditch (as well as both the McKay Bypass Canal and McKay Bypass Pipeline) are outside the COU; these features are not maintained by DOE-LM.

### No Name Gulch

This drainage is located downstream of the Landfill Pond. A surface-water diversion ditch is constructed around the perimeter of the PLF to divert surface-water runoff around the landfill area to No Name Gulch. Effluent from the PLFTS and runoff from the area surrounding the Landfill Pond are the sole surface-water sources to the Landfill Pond. The Landfill Pond is normally operated in a flow-through configuration, although the pool level often drops below the outlet works.

### North Walnut Creek

Runoff from the northern portion of the COU flows into this drainage, which has four ponds (Ponds A-1, A-2, A-3, and A-4). The combined capacity of the A-Series Ponds is approximately 197,000 cubic meters ($m^3$) (52 million gallons or 160 acre-feet [ac-ft]). In the normal operational configuration, Ponds A-1 and A-2 are bypassed and maintained for supplemental stormwater control and wetland habitat; evaporation or transfer controls water levels in these ponds. North Walnut Creek flow is diverted around Ponds A-1 and A-2 to Pond A-3 for retention. Pond A-3 is discharged in batches to the A-Series "terminal pond" Pond A-4. If routine discharge of retained water is warranted, Pond A-4 is isolated, sampled, and water is released if surface water-quality criteria are met. Criteria for emergency discharge, regardless of pre-discharge pond sampling results, are detailed in the *Emergency Response Plan for Rocky Flats Site Dams* (ERP) (DOE 2007a).

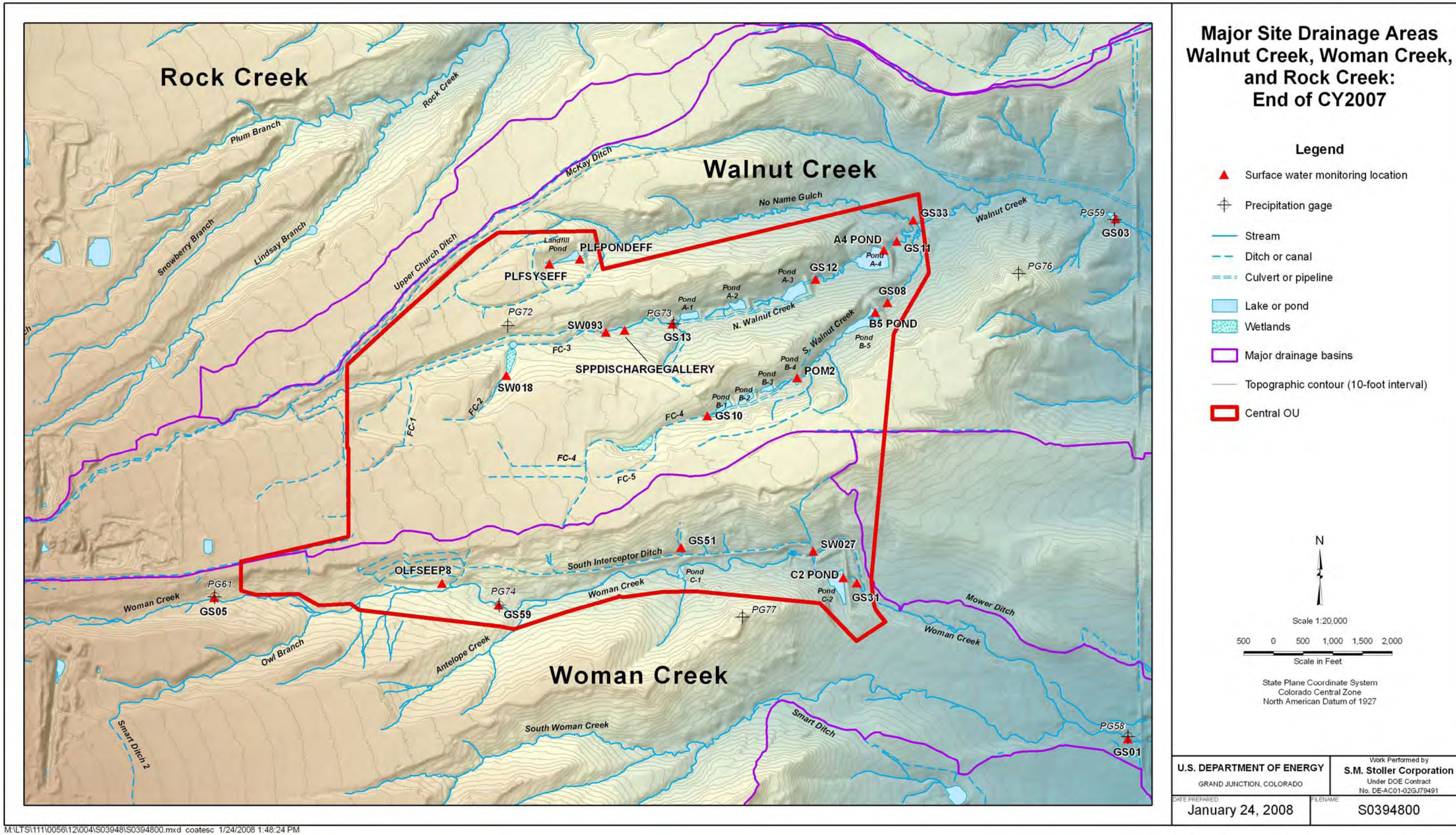



*Figure 3-44. Major Site Drainage Areas - Walnut Creek, Woman Creek, and Rock Creek: End of CY 2007*

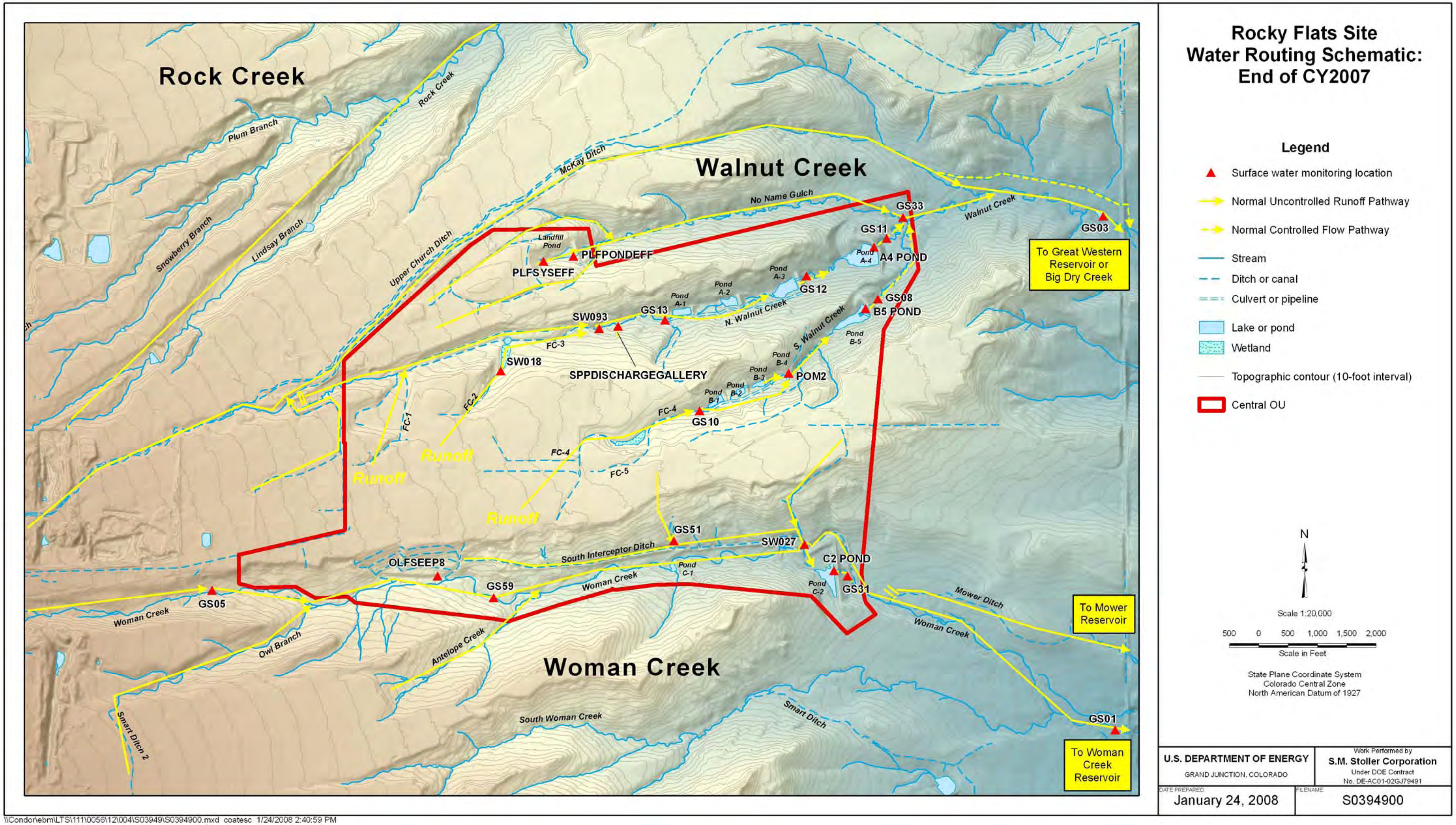



*Figure 3-45. Rocky Flats Site Water Routing Schematic: End of CY 2007*

### *South Walnut Creek*

Runoff from the central portion of the COU flows into this drainage, which has five ponds (Ponds B-1, B-2, B-3, B-4, and B-5). The combined capacity of the South Walnut Creek B-Series Ponds is approximately 102,000 $m^3$ (27 million gallons or 83 ac-ft). Ponds B-1, B-2, and B-3 are bypassed and maintained for supplemental stormwater control and wetland habitat; evaporation or transfer controls water levels in these ponds. South Walnut Creek flow is diverted around Ponds B-1, B-2, and B-3 and into Pond B-4, which flows directly into “terminal pond” Pond B-5. If routine discharge of retained water is warranted, Pond B-5 is sampled and water is released if surface water-quality criteria are met. Criteria for emergency discharge, regardless of pre-discharge pond sampling results, are detailed in the ERP.

### Woman Creek

South of the COU is Woman Creek, which flows through Pond C-1 and off Site onto Refuge lands toward Indiana Street. The Woman Creek drainage basin extends eastward from the base of the foothills, near Coal Creek Canyon, to Standley Lake. In the current configuration, Woman Creek flows into the Woman Creek Reservoir located east of Indiana Street and upstream of Standley Lake, where the water is held until it is pump-transferred to Big Dry Creek by the Woman Creek Reservoir Authority.

### South Interceptor Ditch

In the southern portion of the COU, and tributary to Woman Creek, is the SID drainage. Surface-water runoff from the southern portion of the COU is captured by the SID, which flows from west to east into Pond C-2. If routine discharge of retained water is warranted, Pond C-2 is sampled and water is released to Woman Creek if surface water-quality criteria are met. Criteria for emergency discharge, regardless of pre-discharge pond sampling results, are detailed in the ERP.

### Other Drainages

The third major drainage, other than Walnut and Woman Creeks, is Rock Creek. The Rock Creek drainage covers the northwestern portion of the Refuge. East-sloping alluvial plains to the west, several small stock ponds within the creek bed, and multiple steep gullies and stream channels to the east characterize the drainage channel. This entire basin is outside the COU.

Smart Ditch/South Woman Creek, located south of Woman Creek, is also completely outside the COU. The D-Series Ponds (D-1 and D-2) are located on Smart Ditch. This drainage and these ponds are not maintained by DOE-LM.

#### 3.1.3.2 Surface-Water Hydrologic Data Presentation

### *Flow Data Collection and Computation*

Data obtained at a continuous surface-water gaging station on a stream or conveyance, such as an irrigation ditch, consist of a continuous record of stage,[13] individual measurements of flow

[13] Stage is the water level (in units such as feet or meters) in a conveyance structure.

throughout a range of stages, and notations regarding factors that might affect the relation of stage to flow rate. These data, together with supplemental information such as climatological records, are used to compute daily mean discharges.

Continuous records of stage are obtained with electronic recorders that store stage values at selected time intervals or secondarily with radio-telemetry data-collection platforms that transmit near real-time data at selected time intervals to a central database for subsequent processing. Direct field measurements of flow are made with current meters, using methods adapted by the U.S. Geological Survey, or with flumes or weirs that are calibrated to provide a relation of observed stage to flow rate. These methods are described by Carter and Davidian (1968) and by Rantz (1982a, 1982b).

In computing flow records for nonstandard flow-control devices, results of individual measurements are plotted against the corresponding stage, and stage-flow rate relation curves are constructed. From these curves, rating tables indicating the computed flow rate for any stage within the range of the measurements are prepared. For standard devices (e.g., flumes and weirs), rating tables indicating the flow rate for any stage within the range of the device are prepared based on the geometry of the device. If it is necessary to define extremes of flow outside the range of the device, the curves can be extended using (1) logarithmic plotting, (2) velocity-area studies, (3) results of indirect measurements of peak flow rate, such as slope-area or contracted-opening measurements, and computation of flow over dams or weirs, or (4) step-back-water techniques.

Daily mean discharges are computed by averaging the individual flow measurements using the stage-flow rate curves or tables. If the stage-flow rate relation is subject to change because of frequent or continual change in the physical features that form the control, the daily mean discharge is determined by the shifting-control method, in which correction factors based on the individual flow rate measurements and notes by the personnel making the measurements are applied to the gage heights before the flow rates are determined from the curves or tables. This shifting-control method also is used if the stage-flow rate relation is changed temporarily because of aquatic vegetation growth or debris on the control. For some gaging stations, formation of ice in the winter can obscure the stage-flow rate relations so that daily mean discharges need to be estimated from other information, such as temperature and precipitation records, notes of observations, and records for other gaging stations in the same or nearby basins for comparable periods.

For most gaging stations, there may be periods when no gage-height record is obtained or the recorded gage height is faulty so that it cannot be used to compute daily mean discharge or contents. This record loss occurs when recording instruments malfunction or otherwise fail to operate properly, intakes are plugged, the stilling well is frozen, or for various other reasons. For such periods, the daily discharges are estimated from the recorded range in stage, previous or following record, field discharge measurements, climatological records, and comparison with other gaging-station records from the same or nearby basins. Information explaining how estimated daily discharge values are identified in gaging-station records is provided in the "Identifying Estimated Daily Discharge" section.

## Data Presentation

The information published for each continuous-record surface-water gaging station consists of six parts: the station description, a map showing the drainage area for the station, a plot of the daily mean discharge for the CY(s), a table of daily mean discharge values for the CY with summary data, a tabular statistical summary of monthly mean discharge data for the CY, and a summary statistics table that includes statistical data of annual discharge and runoff. The tables are included in Appendix A, while the other information is presented below.

## Station Description

The station description provides, under various headings, descriptive information included gaging-station location, drainage area, period of record, and gage information. The following information is provided:

- Location—This entry provides the gaging-station state plane coordinates and geographic location. Gaging station state plane coordinates were obtained by geographic positioning system or digitized from Site geographic information system (GIS) coverages.
- Drainage Area—This entry provides the drainage area (in acres) of the gaged basin. If, because of unusual natural conditions or artificial controls, some part of the basin does not contribute flow to the total flow measured at the gage, the noncontributing drainage area also is identified. Drainage area is usually measured using digital techniques and the most accurate maps available. Because the type of map available might vary from one drainage basin to another, the accuracy of digitized drainage areas also can vary. Drainage areas are updated as better maps become available. Some of the gaging stations included in this report measure stage and flow rate in channels that convey water to or from reservoirs or other features; these channels might have little or no contributing drainage area. Drainage areas in this report were provided by Site GIS coverages.[14]
- Period of Record—This entry provides the period for which the Site has been collecting records at the gage. This entry includes the month and year of the start of collection of hydrologic records by the Site and the words “to current year” if the records are to be continued into the following year.
- Gage—This entry provides the type of gage currently in use, and a condensed history of the types and locations of previous gages.

## Daily Mean Discharge Values

The daily mean discharge values computed for each gaging station during a CY are listed in the body of the data tables in Appendix A. In the monthly “Flow Rate” summary part of the table, the line headed “Average” lists the average flow rate, in cfs, during the month; and the lines headed “Maximum” and “Minimum” list the maximum and minimum daily mean discharges for each month. Total discharge for the month also is expressed in cubic feet (“Cubic Feet”), gallons (“Gallons”), and acre-feet (“Acre-Feet”). The term “Partial Data” denotes a month with incomplete data.

[14] Drainage area maps show Site configuration at the end of CY 2007.

### Summary Statistics

A section of the table titled "Annual Summaries for CY07" follows the monthly mean data section. This section provides a statistical summary of annual flow rates and discharge for the labeled CY. The applicable units are to the left of the table value. The term "PARTIAL DATA" denotes a year with incomplete data.

### Identifying Estimated Daily Discharge

Estimated daily discharges published in water-discharge tables and figures of this annual report are identified by *italicizing* individual daily values or through color coding in hydrographs. For periods of no data, a gap is shown on the hydrographs.

### Other Records Available

Information used in the preparation of the records in this report, such as discharge-measurement notes, gage-height records, and rating tables, are on file. Information on the availability of the unpublished information or on the published statistical analyses is available from personnel involved with data collection at the Site.

#### 3.1.3.3 Surface-Water Discharge Data Summaries

***Site-Wide Discharge Summary***

Discharge summaries for the two major Site drainages receiving flow from the COU (Walnut and Woman Creeks) are given on Figure 3-46 and Figure 3-47.[15] Walnut Creek flows are measured at GS03 and Woman Creek flows are measured at GS01. Figure 3-48 shows the relative total CY 1997−2007 discharge volumes from the major Site drainages as measured at Site POEs and POCs. Through CY 2004, Walnut Creek discharged larger volumes than Woman Creek due to the contribution of imported water and runoff from impervious surfaces. After final closure in CY 2005, the reduction of discharge in Walnut Creek and the corresponding change in relative volumes is clearly observed.

[15] The pre-closure period is for the dates 1/1/97−10/1/05; the post-closure period is for the dates 10/1/05−12/31/07.

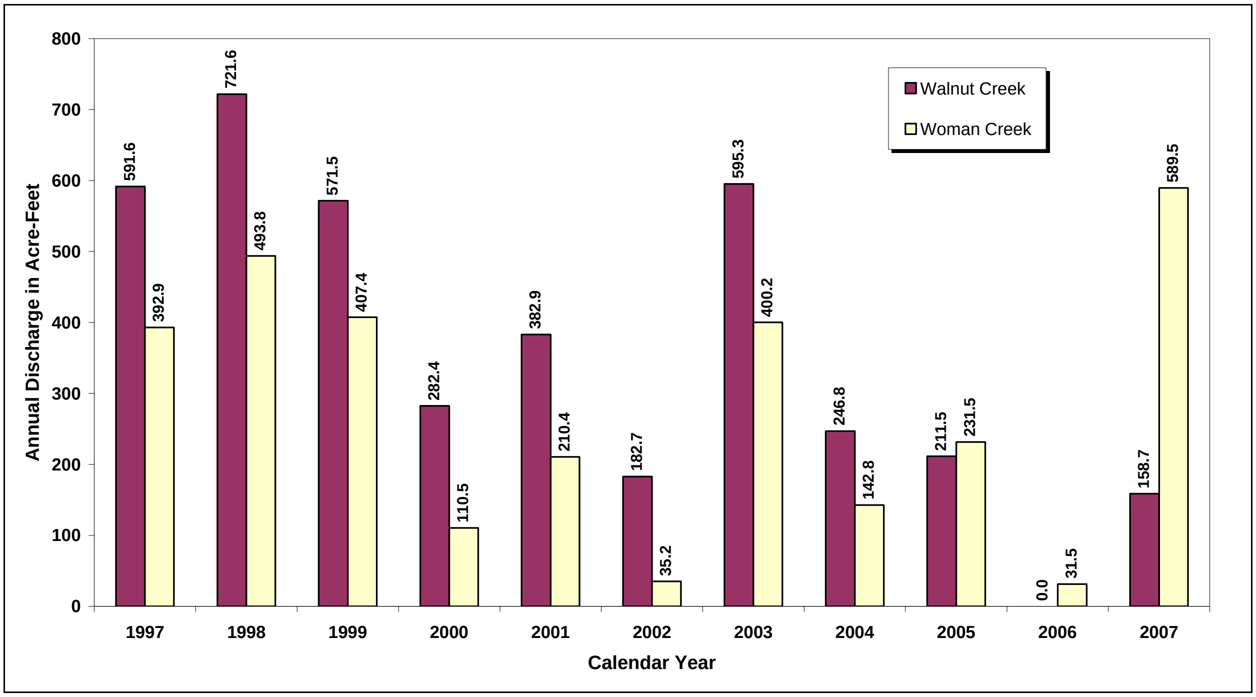



*Figure 3-46. Annual Discharge Summary from Major Site Drainages: CY 1997−2007*

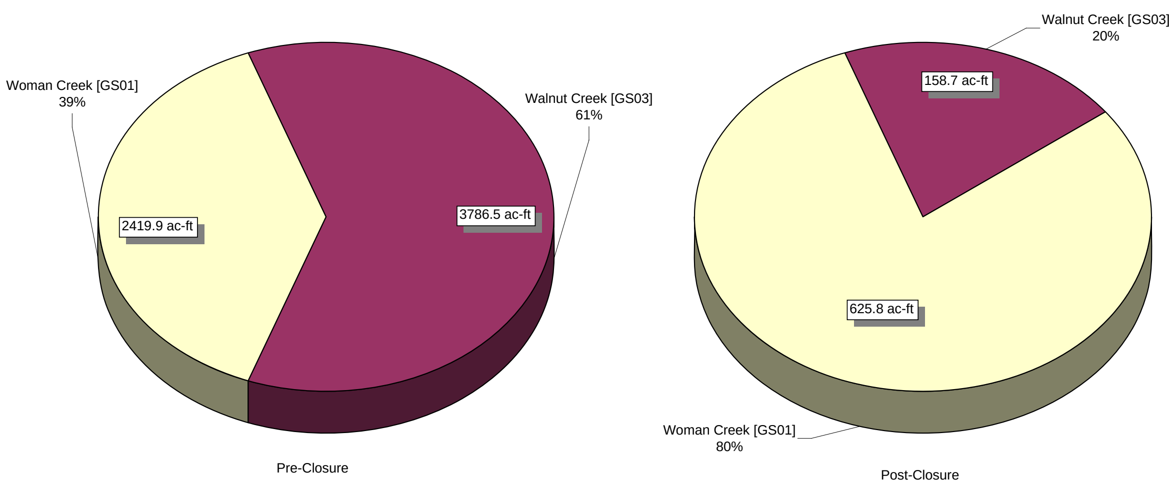



*Figure 3-47. Relative Total Discharge Summary from Major Site Drainages: Pre- and Post-Closure Periods*

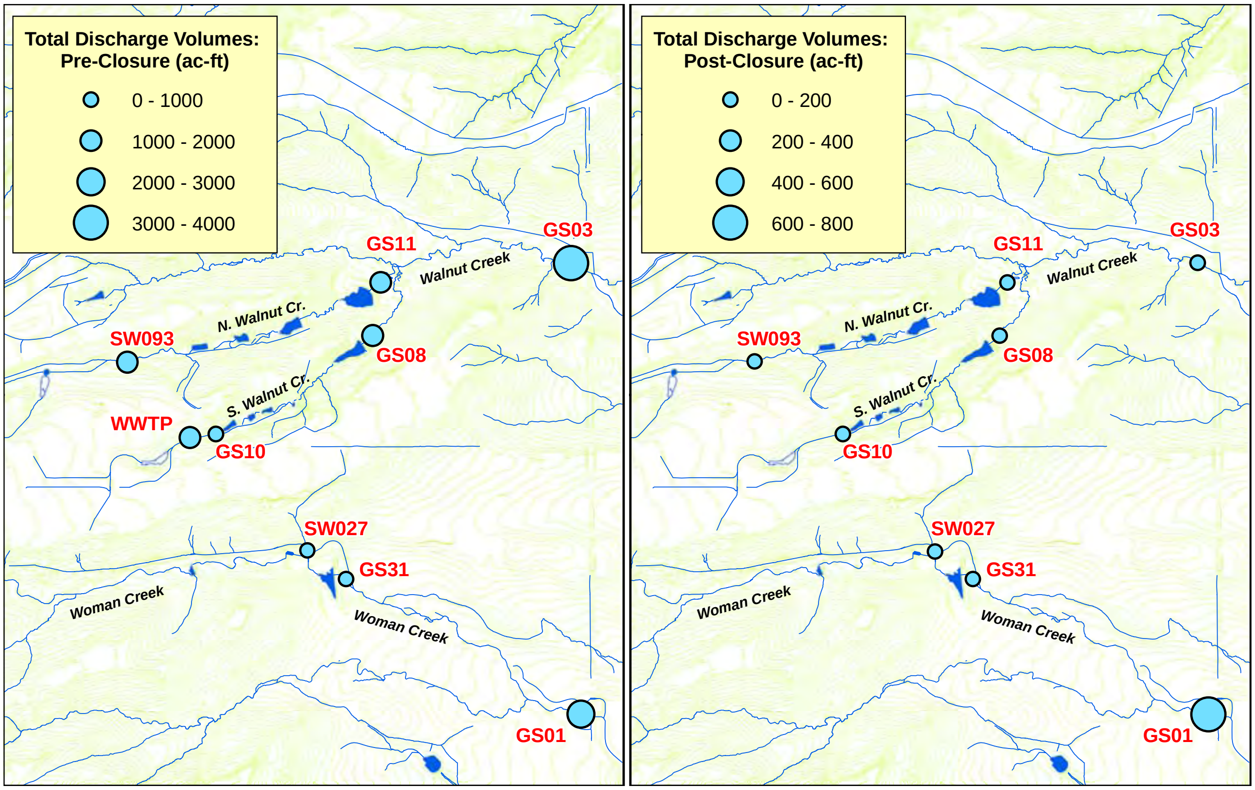
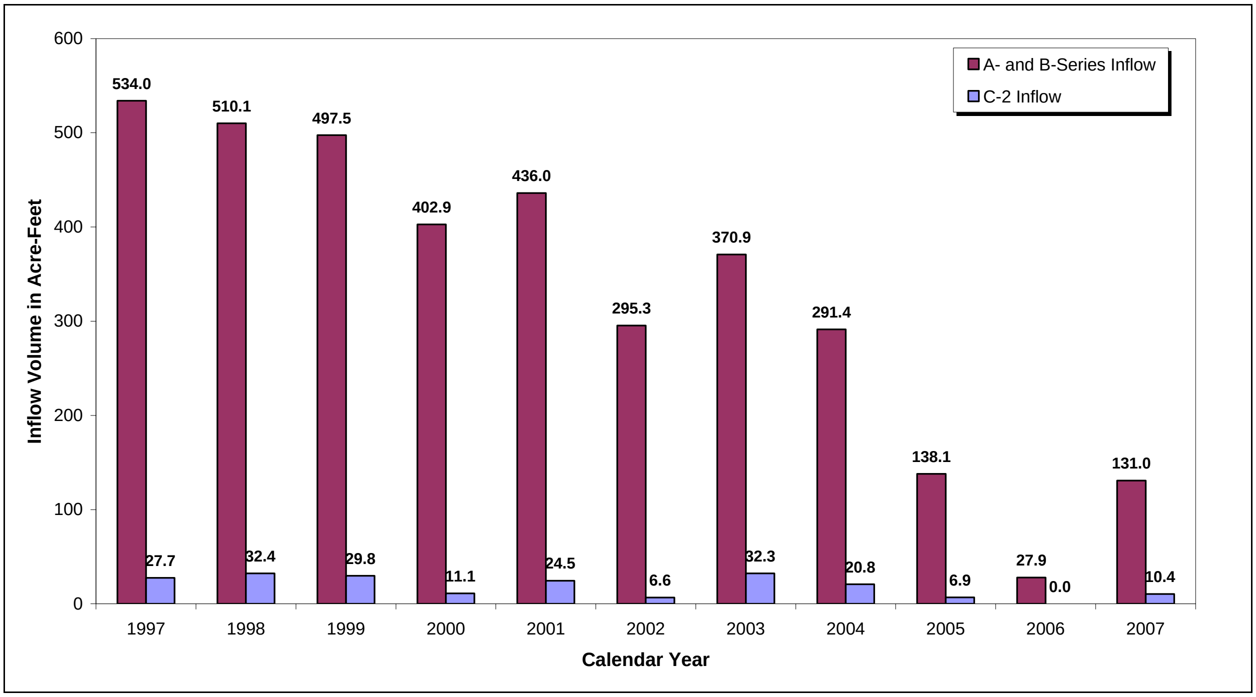



*Figure 3-48. Map Showing Relative CY 1997−2007 Discharge Volumes for POEs and POCs: Pre- and Post Closure Periods*

### *Pond Discharge Summary*

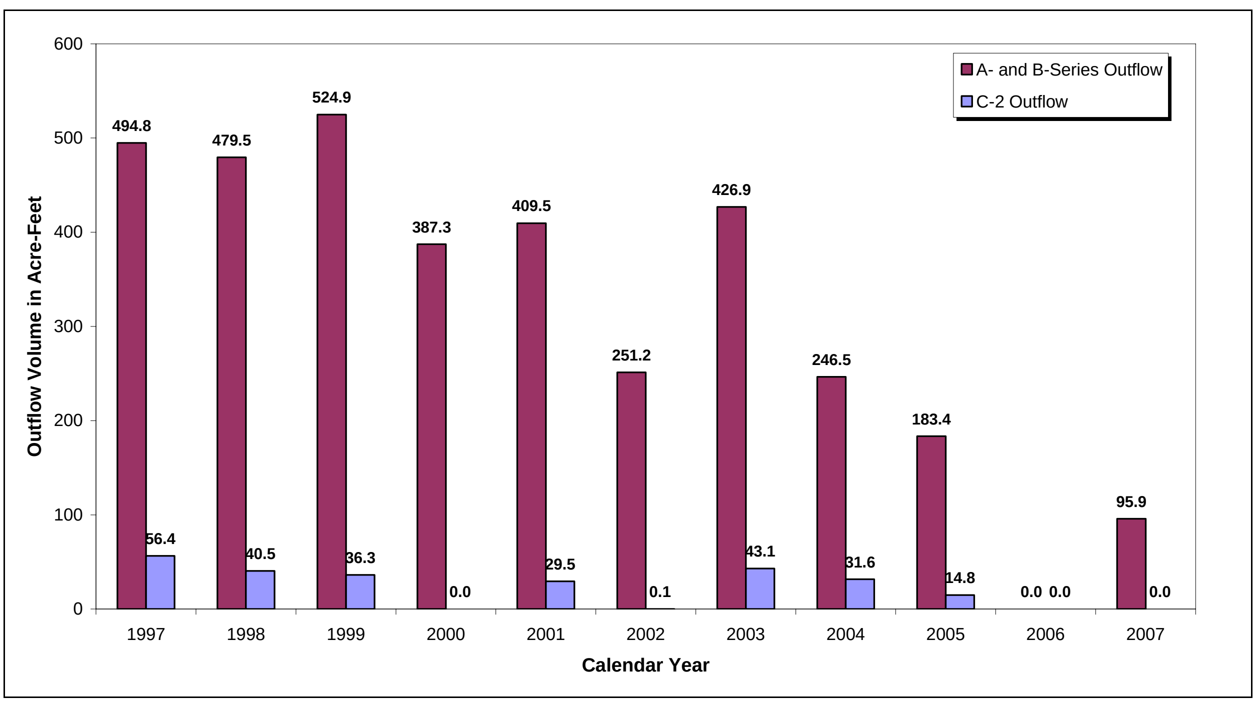
Figure 3-49 and Figure 3-50 show the annual ponds inflows and outflows, respectively. Due to the intermittent pump transfers of Pond B-5 water to Pond A-4, the volumes for the A- and B-Series Ponds are combined. The reduction in pond water volumes as the Site progressed toward closure is clearly observed. Figure 3-51 and Figure 3-52 show the relative total CY 1997−2007 discharge volumes from the ponds (as measured at GS08, GS11, and GS31) and from the major drainages tributary to the ponds (as measured at GS10, SW027, SW091, SW093, and the former Waste Water Treatment Plant [WWTP] [995POE]).[16, 17] Pond inflows do not necessarily equal outflows for any given year due to the storage of water in the ponds across water years, evaporative/seepage losses/gains, and local runoff to the ponds.

[16] The WWTP was removed from service on November 4, 2004.
[17] The pre-closure period is for the dates 1/1/97−10/1/05; the post-closure period is for the dates 10/1/05−12/31/07.




Notes: A- and B-Series Inflow is the sum of GS10, the former WWTP, and SW093. The C-2 Inflow is the volume measured at SW027.

*Figure 3-49. Pond Inflows: CY 1997−2007*




Notes: A- and B-Series Outflow is the sum of GS11 and GS08. The C-2 Outflow is the volume measured at GS31.

*Figure 3-50. Pond Outflows: CY 1997−2007*

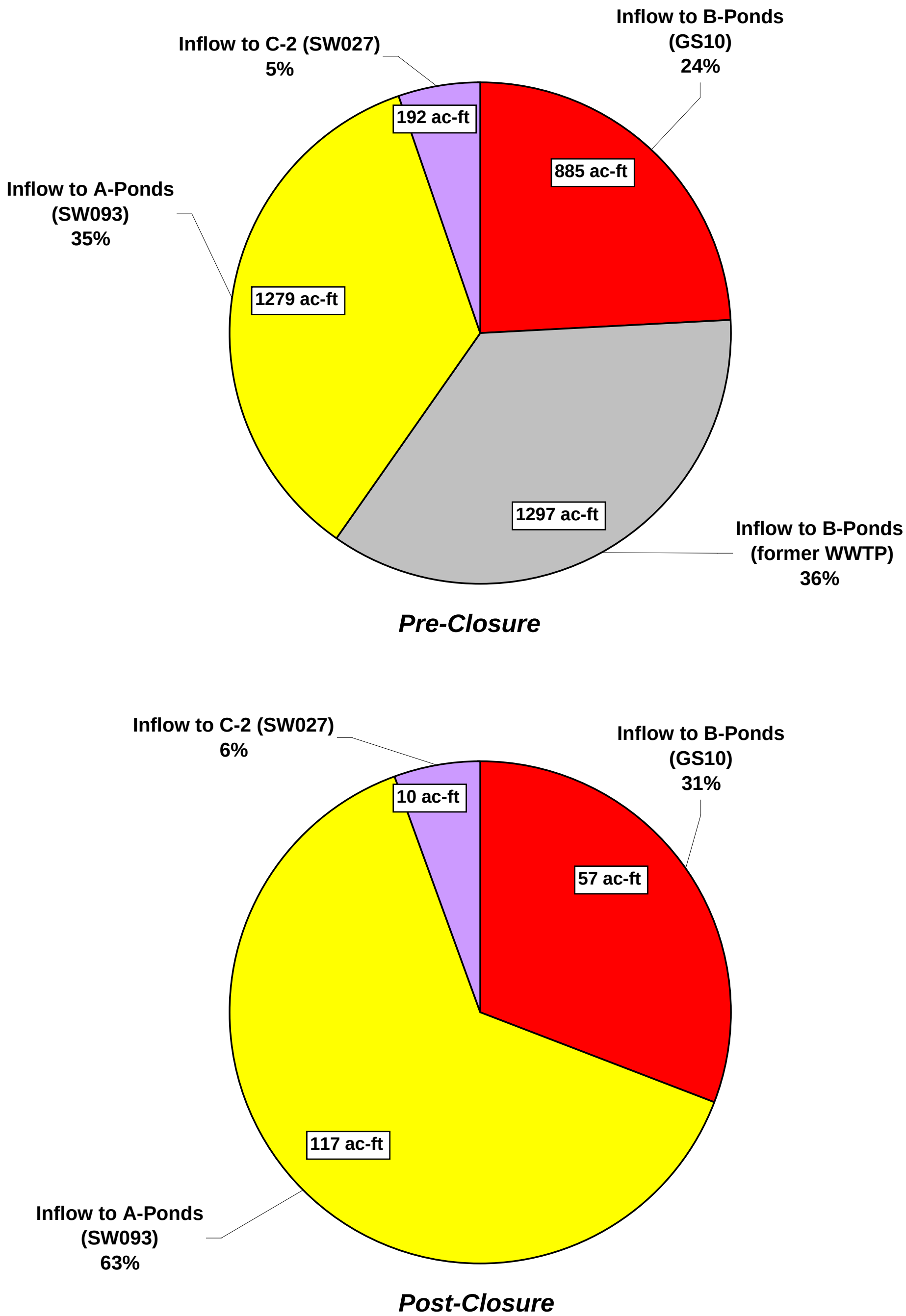



*Figure 3-51. Relative Total Inflow Volumes for Site Ponds: Pre- and Post-Closure Periods*

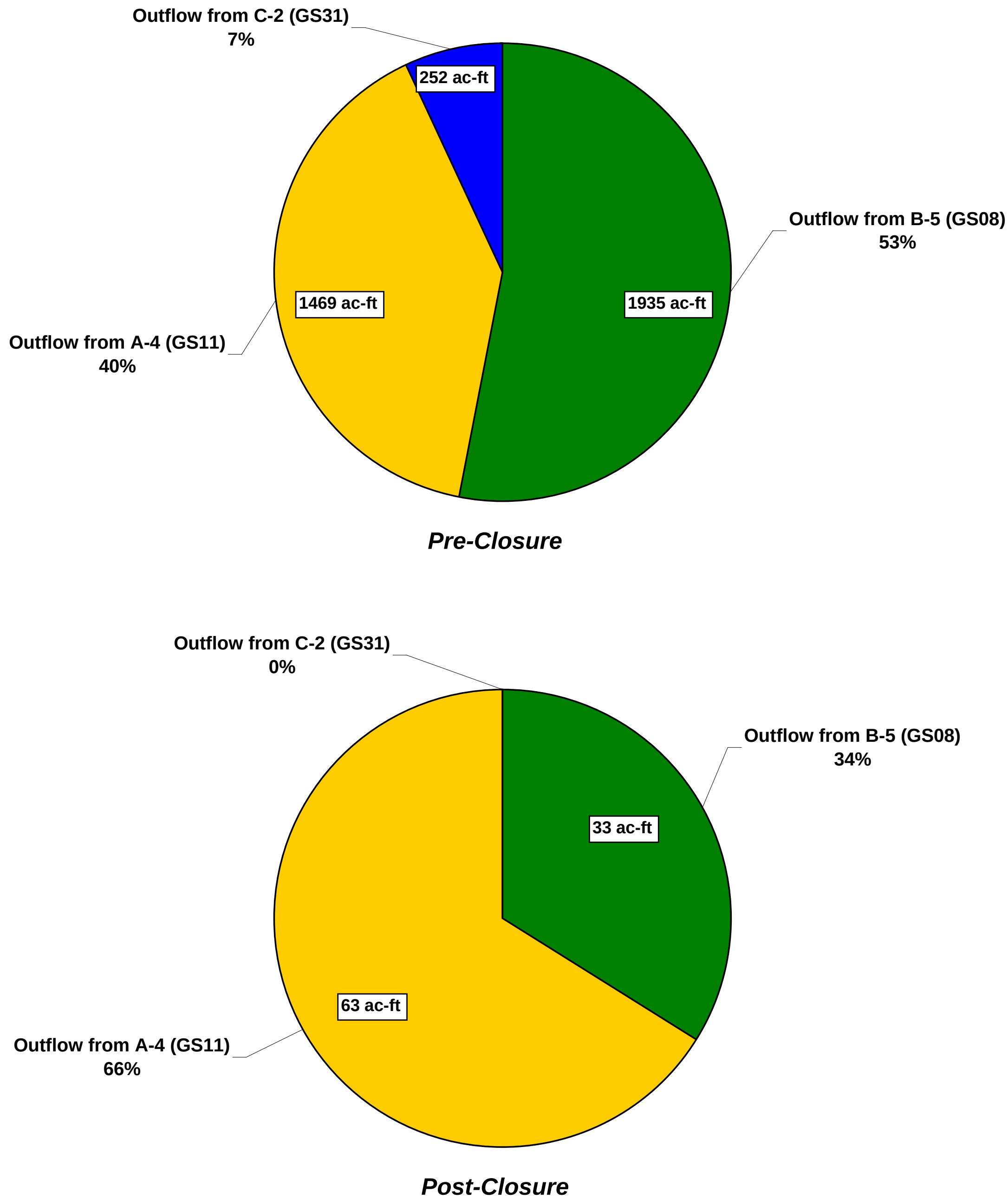



*Figure 3-52. Relative Total Outflow Volumes for Site Ponds: Pre- and Post-Closure Periods*

***GS01: Woman Creek at Indiana Street***

***Location***—Woman Creek 200 feet upstream of Indiana Street; State Plane: E2093824, N744889.

***Drainage Area***—The basin includes the Woman Creek drainage and southern portions of the COU; areas west of Highway 93 also contribute runoff (total drainage acreage undetermined).

***Period of Record***—September 16, 1991, to current year.

***Gage***—Water-stage recorder and 18-inch Parshall flume (flume is located just east of Indiana Street, sampling conducted on Site property); prior to March 24, 1998, flow measurement was at the on-site sampling location using a 9-inch Parshall flume.

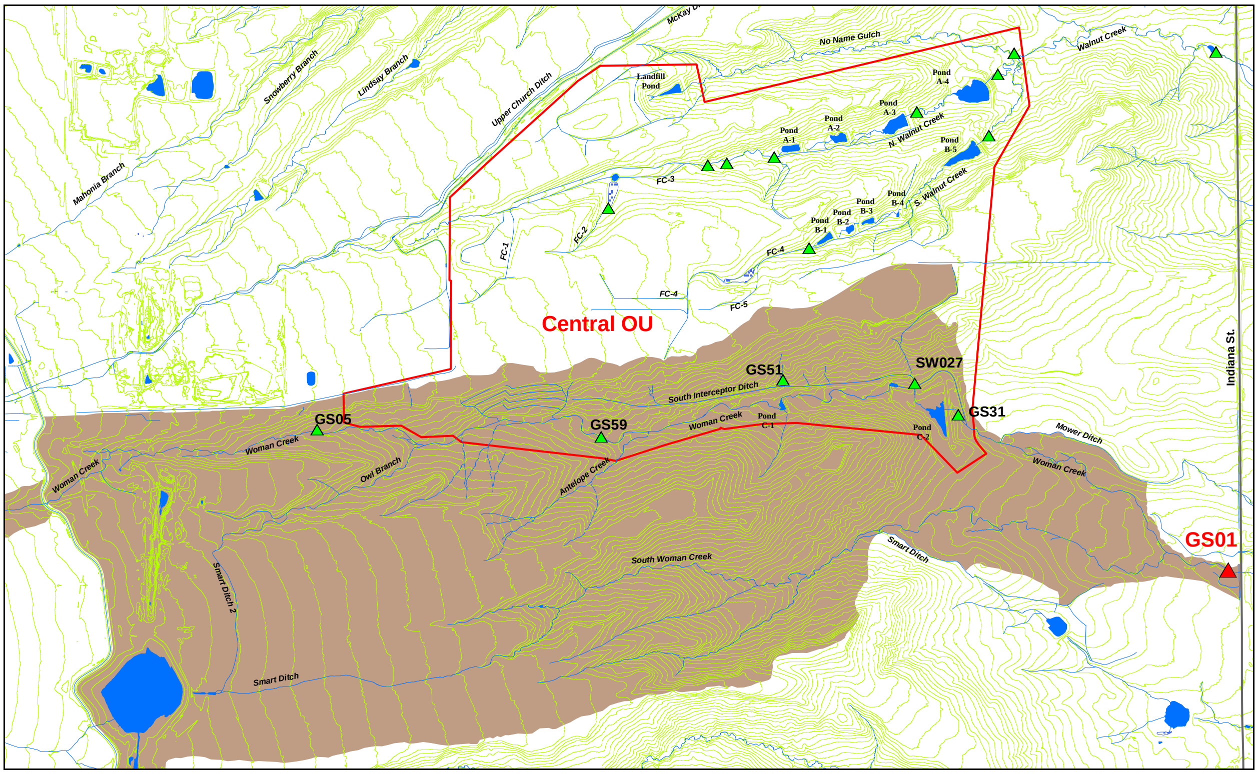



*Figure 3-53. GS01 Drainage Area*

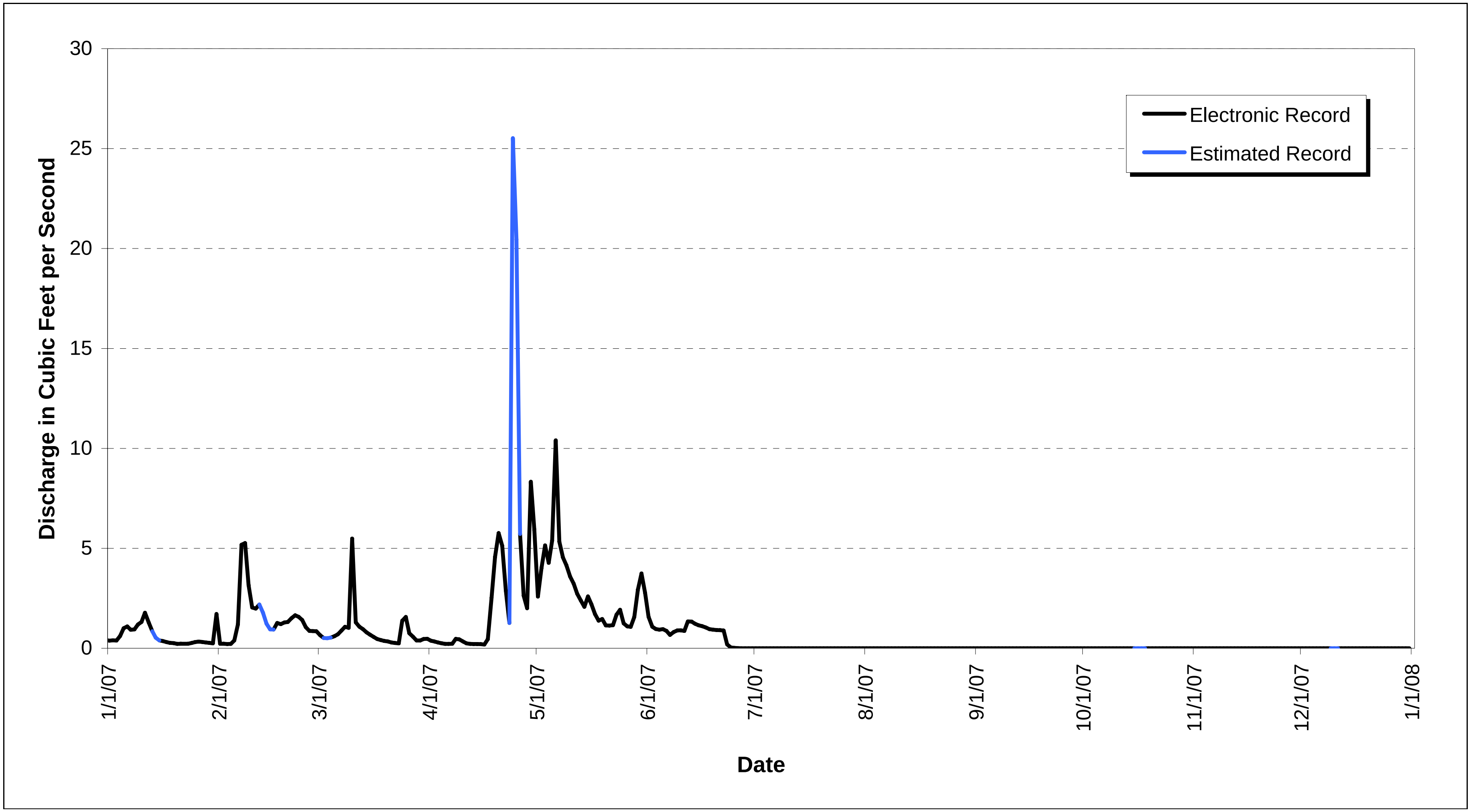



*Figure 3-54. CY 2007 Mean Daily Hydrograph at GS01: Woman Creek at Indiana Street*

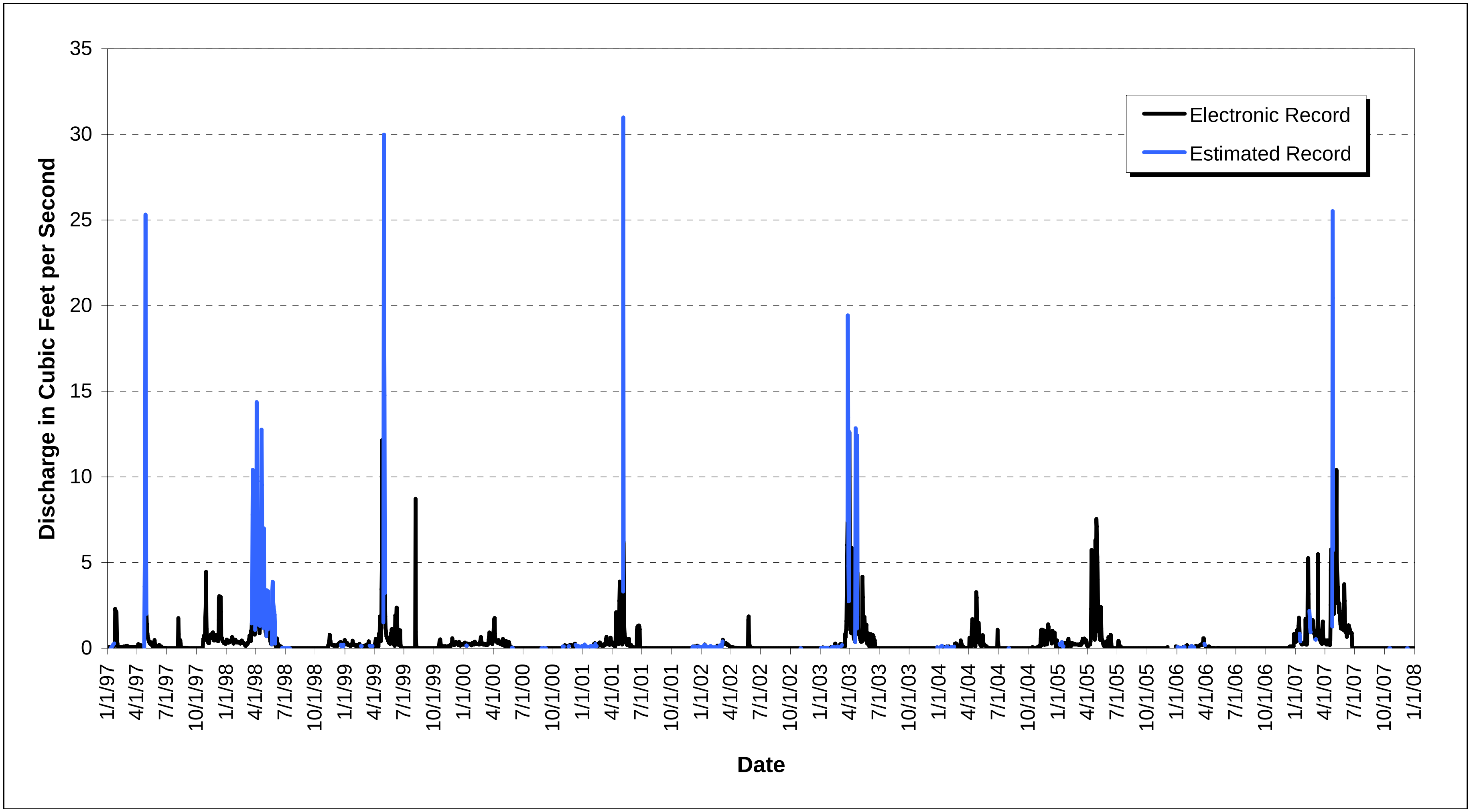



*Figure 3-55. CY 1997−2007 Mean Daily Hydrograph at GS01: Woman Creek at Indiana Street*

## *GS03: Walnut Creek at Indiana Street*

***Location***—Walnut Creek at Flume Pond outlet upstream of Indiana Street; State Plane: E2093618, N753646.

***Drainage Area***—The basin includes the Walnut Creek drainage and the majority of the COU; areas west of Highway 93 also contribute runoff (total drainage acreage undetermined).

***Period of Record***—September 2, 1991, to current year.

***Gage***—Water-stage recorder and parallel 6-inch and 36-inch Parshall flumes prior to November 5, 2002. Rated stream section during flume construction (GS03T; November 5, 2002−February 12, 2003). Three-foot HL flume starting February 12, 2003.

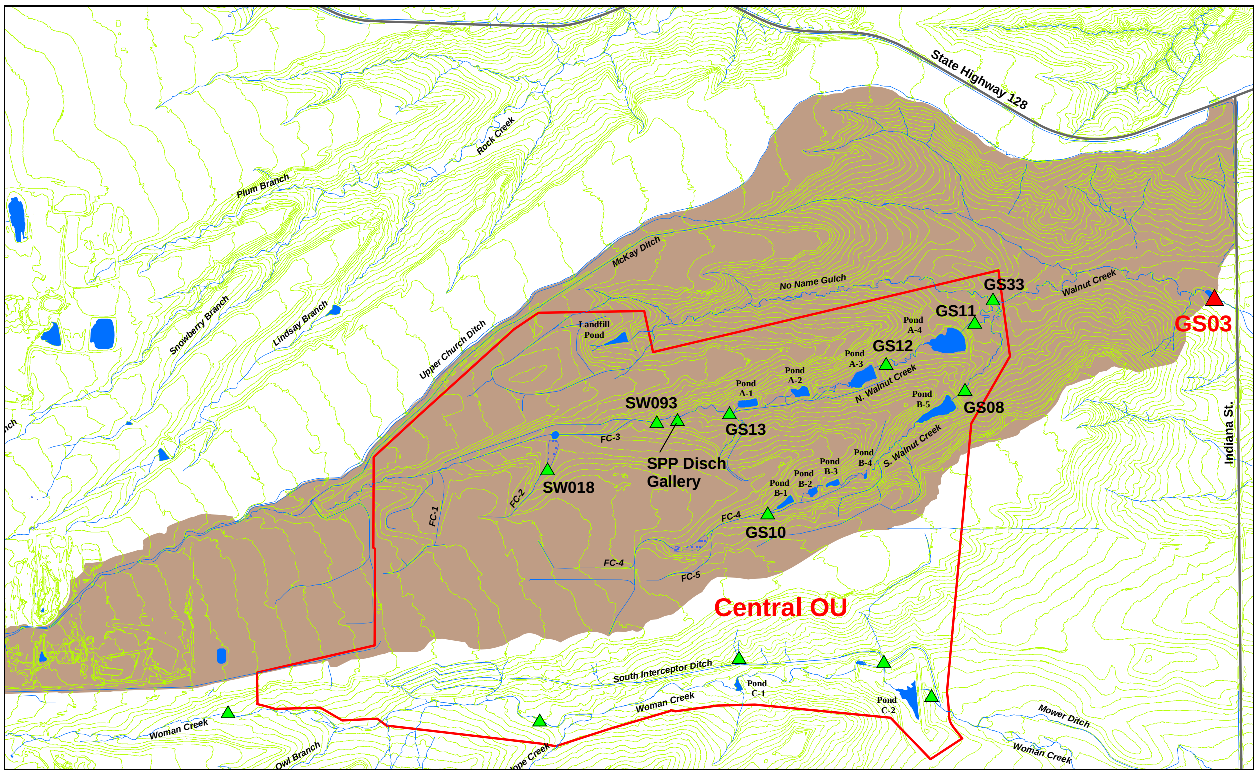



*Figure 3-56. GS03 Drainage Area*

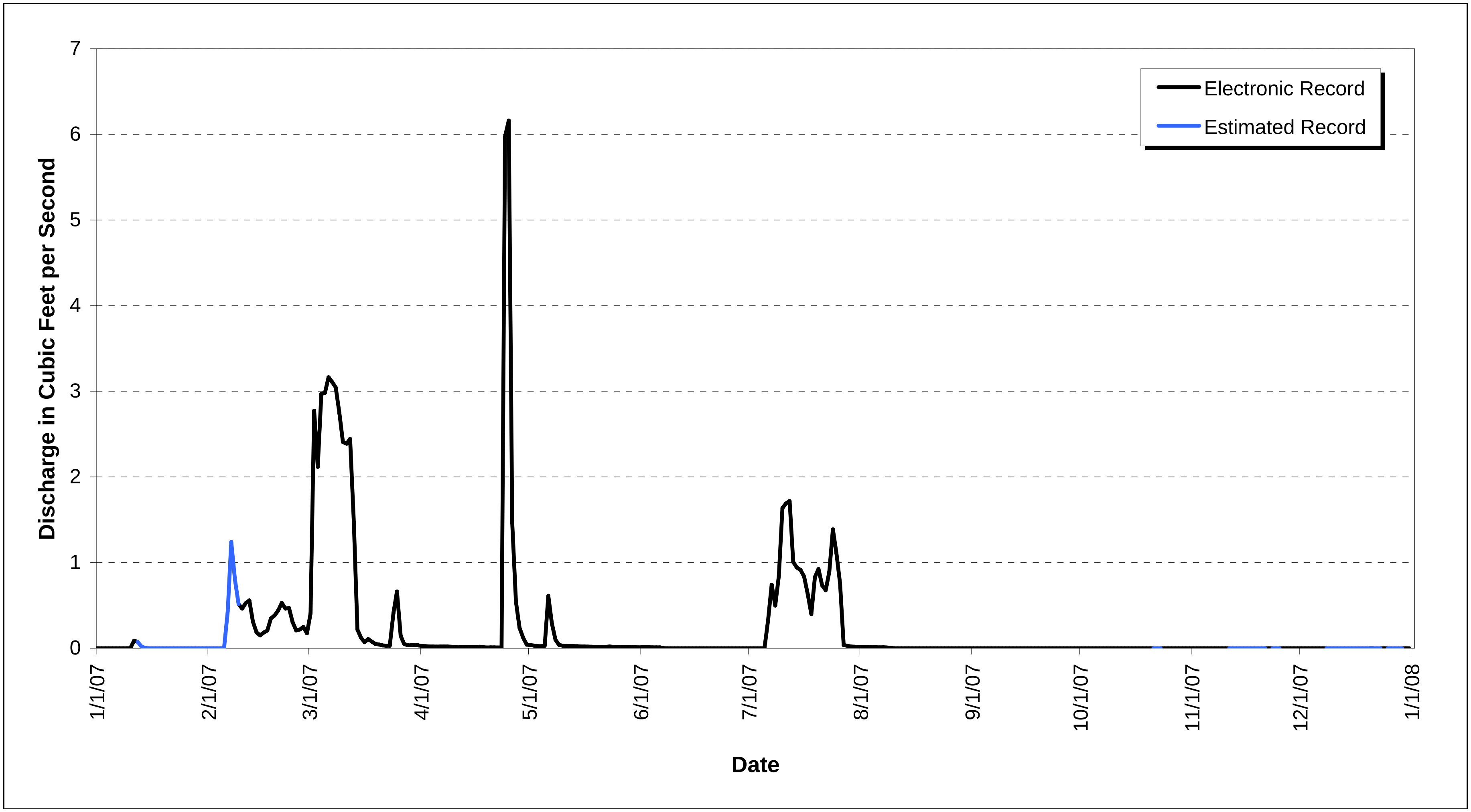



*Figure 3-57. CY 2007 Mean Daily Hydrograph at GS03: Walnut Creek at Indiana Street*

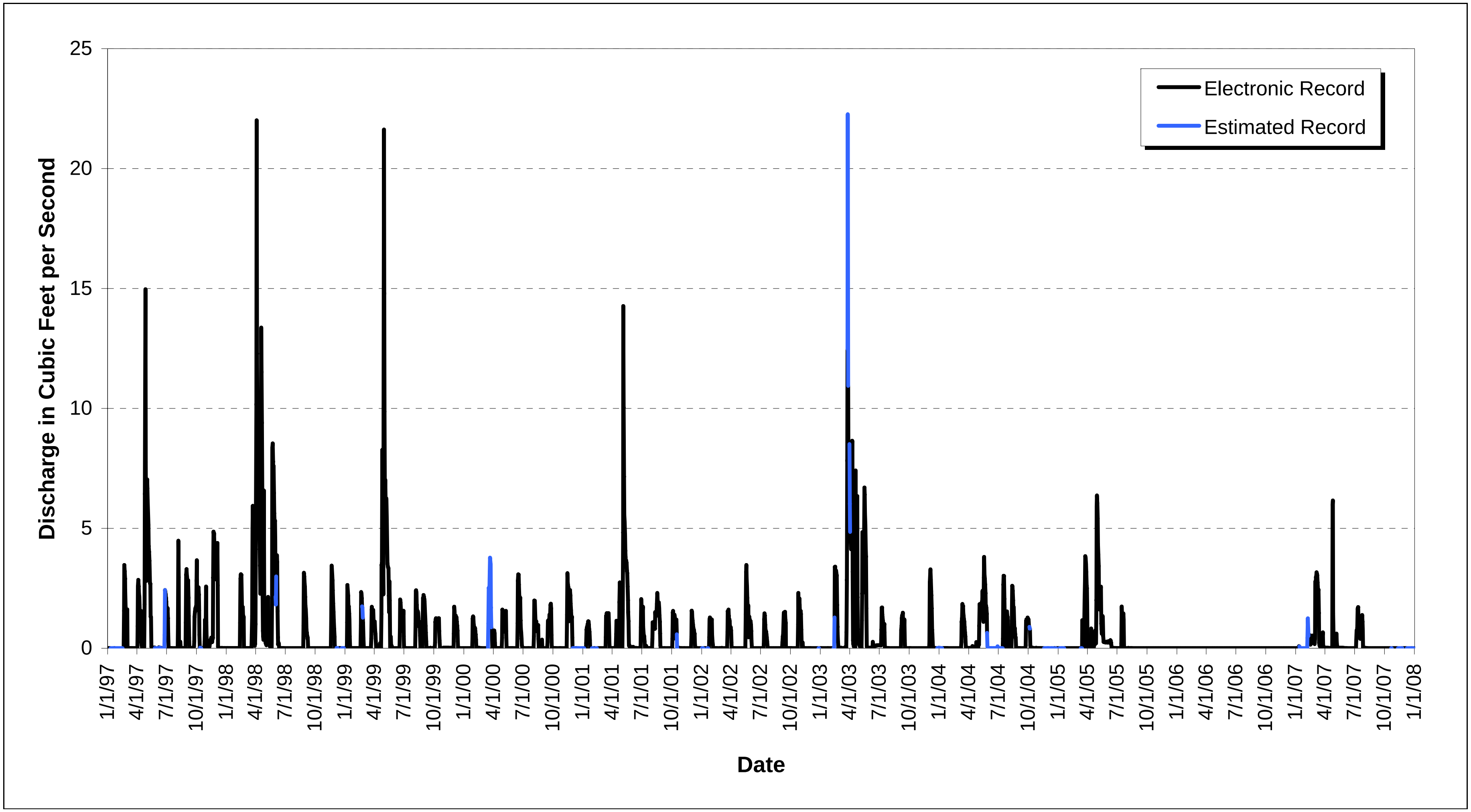



*Figure 3-58. CY 1997−2007 Mean Daily Hydrograph at GS03: Walnut Creek at Indiana Street*

### *GS05: North Woman Creek at West Fenceline*

***Location***—Woman Creek east of western Site boundary; State Plane: E2078429, N747264.

***Drainage Area***—The basin includes a portion of the Woman Creek drainage; areas west of Highway 93 also contribute runoff (total drainage acreage undetermined).

***Period of Record***—September 23, 1991, to current year.

***Gage***—Water-stage recorder and 9-inch Parshall flume with weir insert.

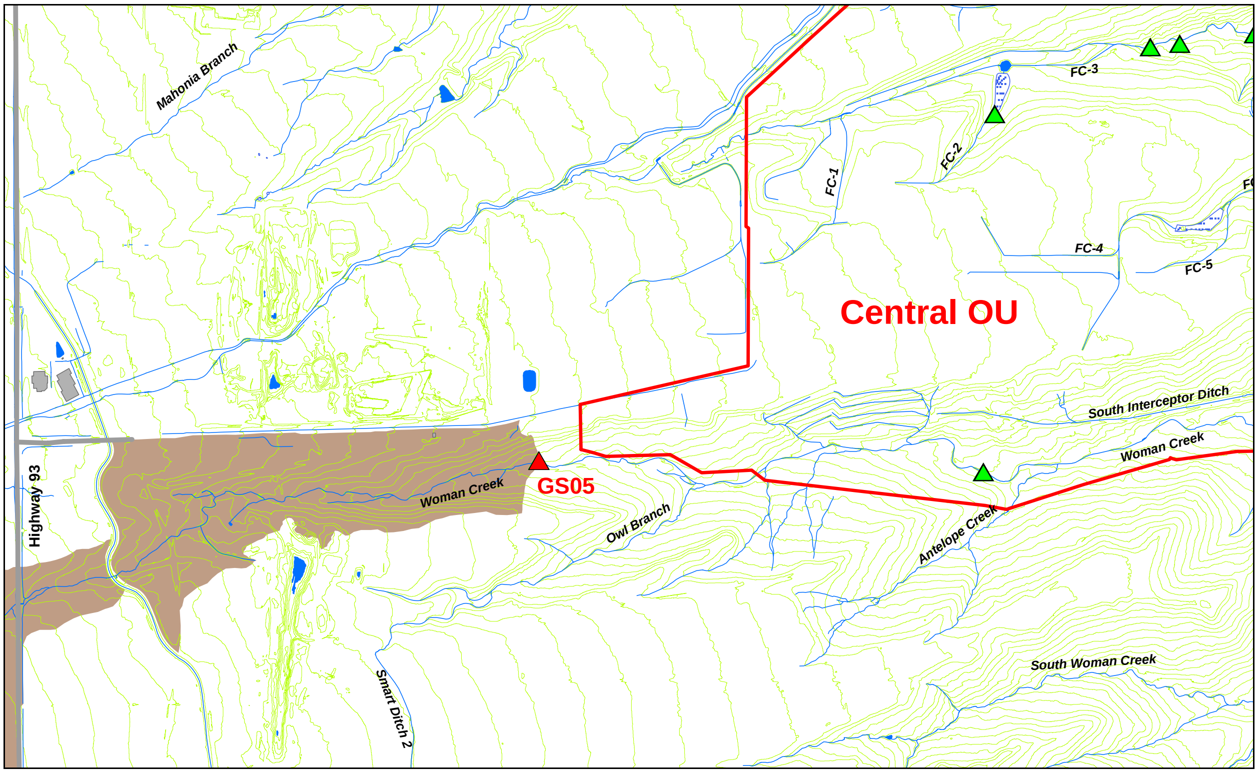



*Figure 3-59. GS05 Drainage Area*

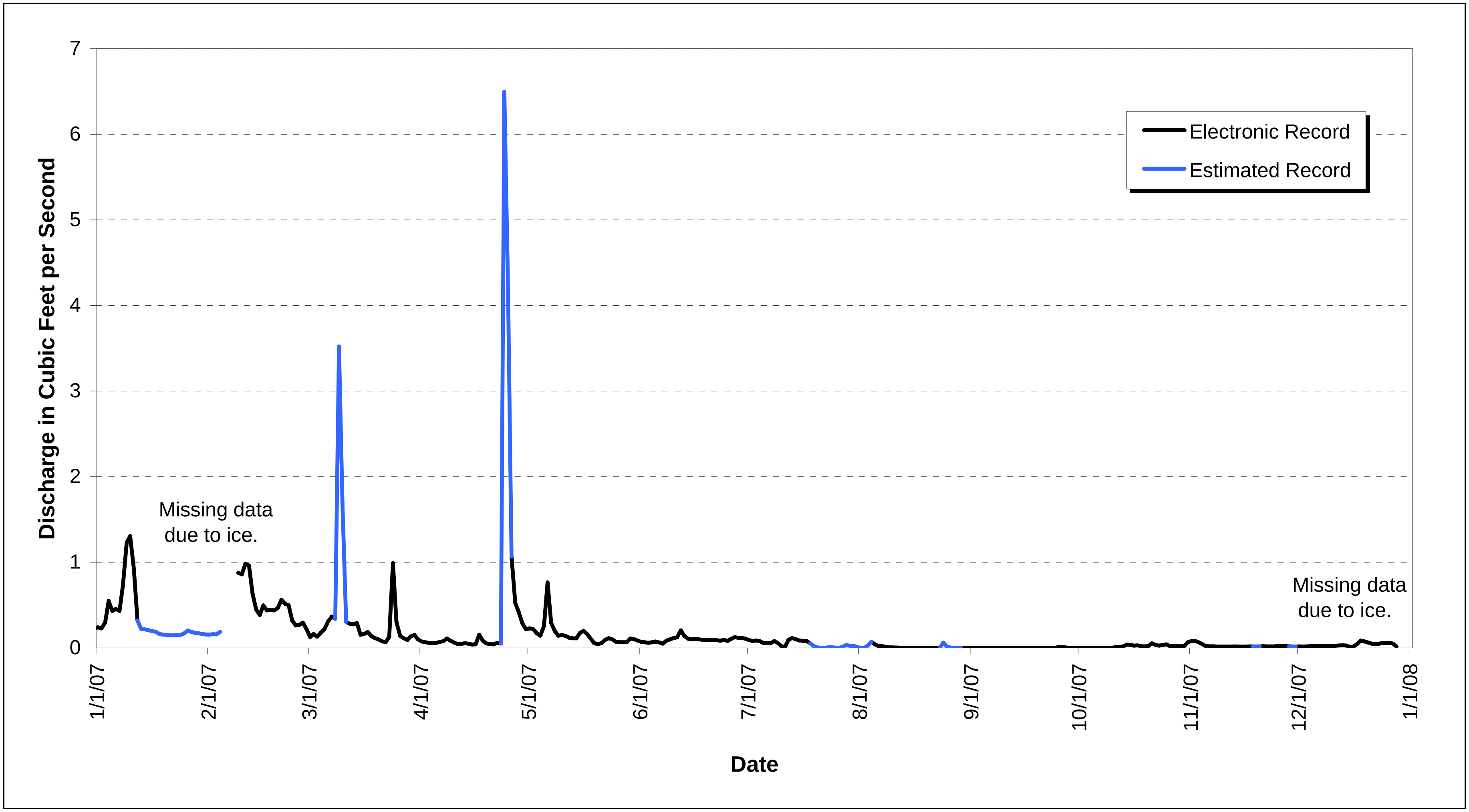



*Figure 3-60. CY 2007 Mean Daily Hydrograph at GS05: North Woman Creek at West Fenceline*

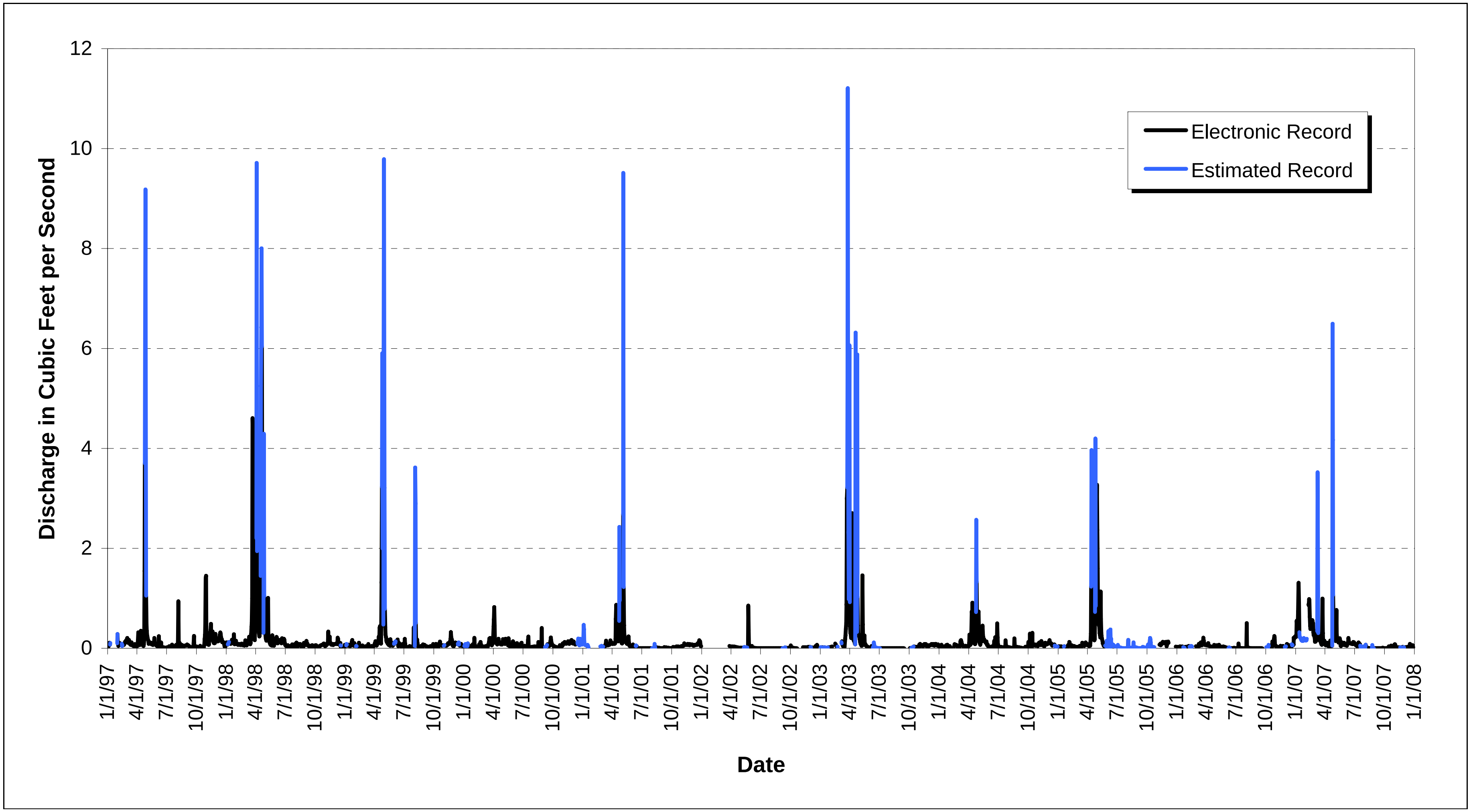



*Figure 3-61. CY 1997−2007 Mean Daily Hydrograph at GS05: North Woman Creek at West Fenceline*

## *GS08: South Walnut Creek at Pond B-5 Outlet*

***Location***—South Walnut Creek at Pond B-5 outlet; State Plane: E2089778, N752231.

***Drainage Area***—The basin includes the South Walnut Creek drainage and central portions of the COU (total of 311.0 acres).

***Period of Record***—March 23, 1994, to current year.

***Gage***—Water-stage recorder and 24-inch Parshall flume.

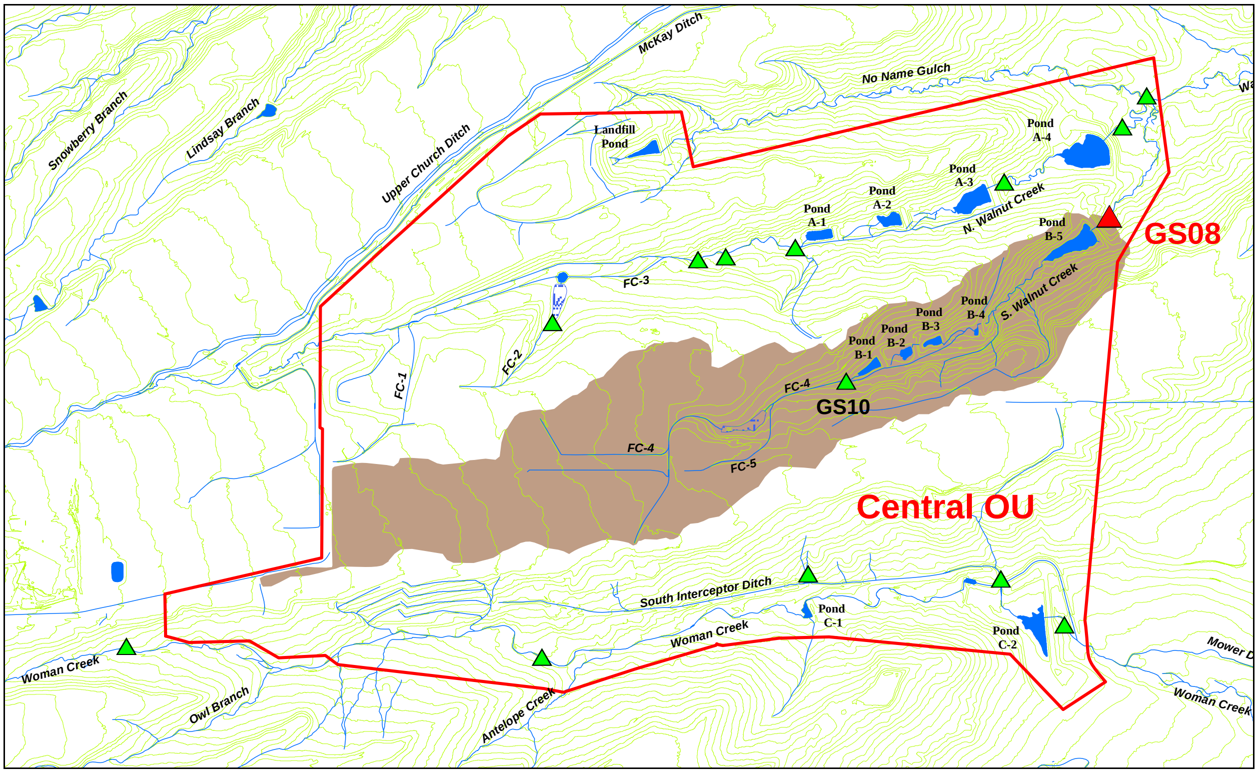



*Figure 3-62. GS08 Drainage Area*

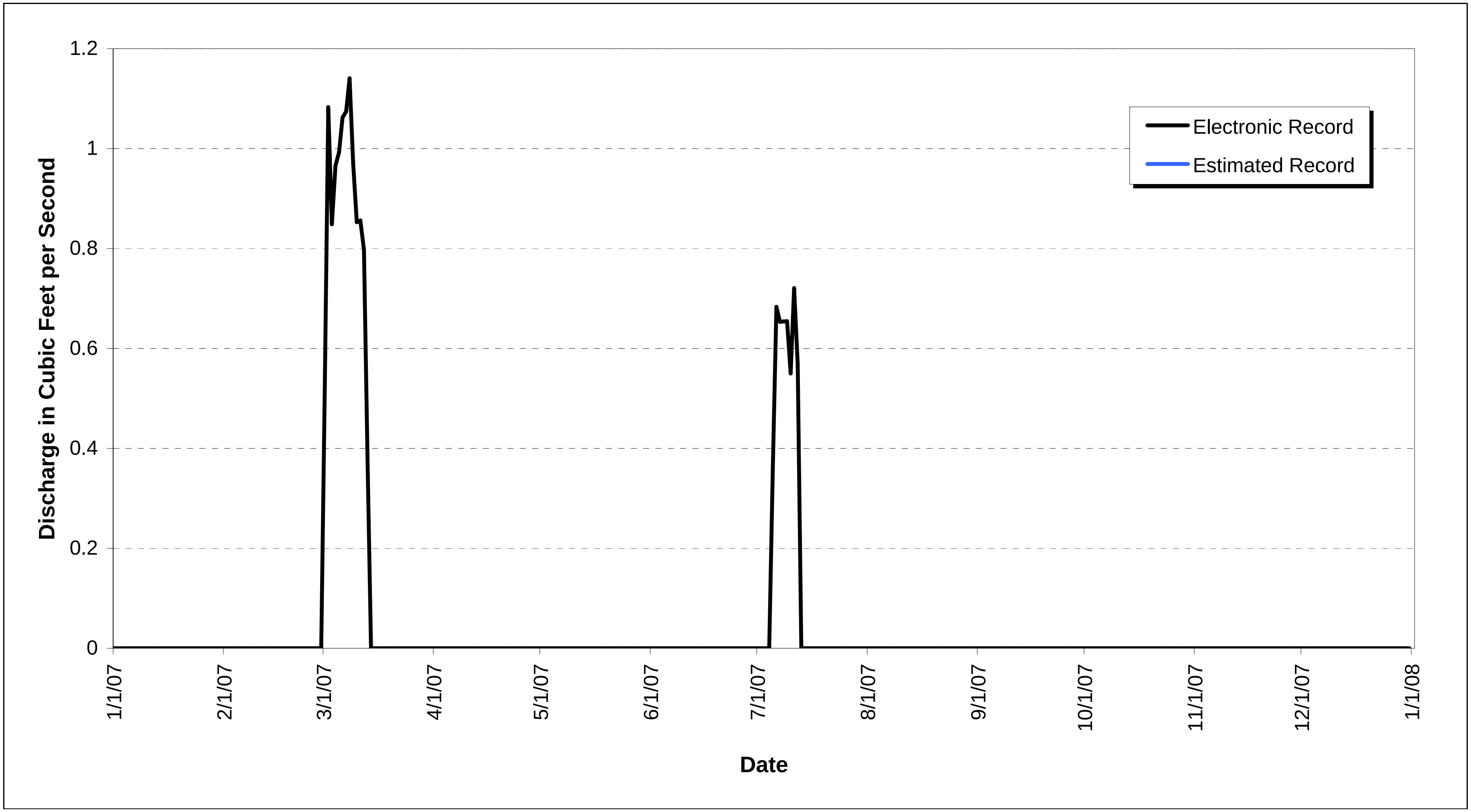



*Figure 3-63. CY 2007 Mean Daily Hydrograph at GS08: South Walnut Creek at Pond B-5 Outlet*

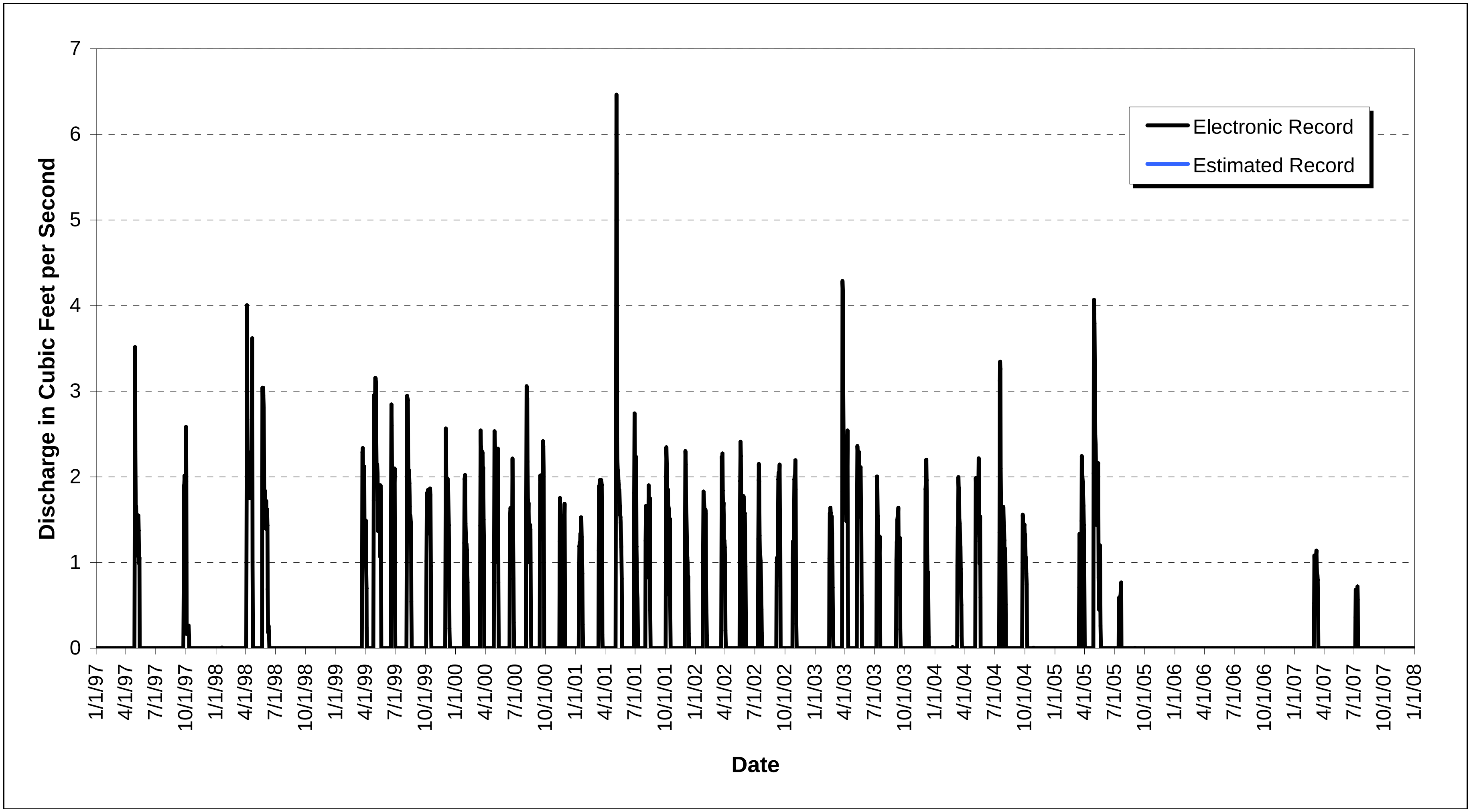



*Figure 3-64. CY 1997−2007 Mean Daily Hydrograph at GS08: South Walnut Creek at Pond B-5 Outlet*

### *GS10: South Walnut Creek at Pond B-1 Bypass*

***Location***—South Walnut Creek above Pond B-1 Bypass; State Plane: E2086741, N750329.

***Drainage Area***—The basin includes the central portion of the COU (total of 206.0 acres).

***Period of Record***—April 1, 1993, to current year.

***Gage***—Water-stage recorder and 9-inch Parshall flume with weir insert.

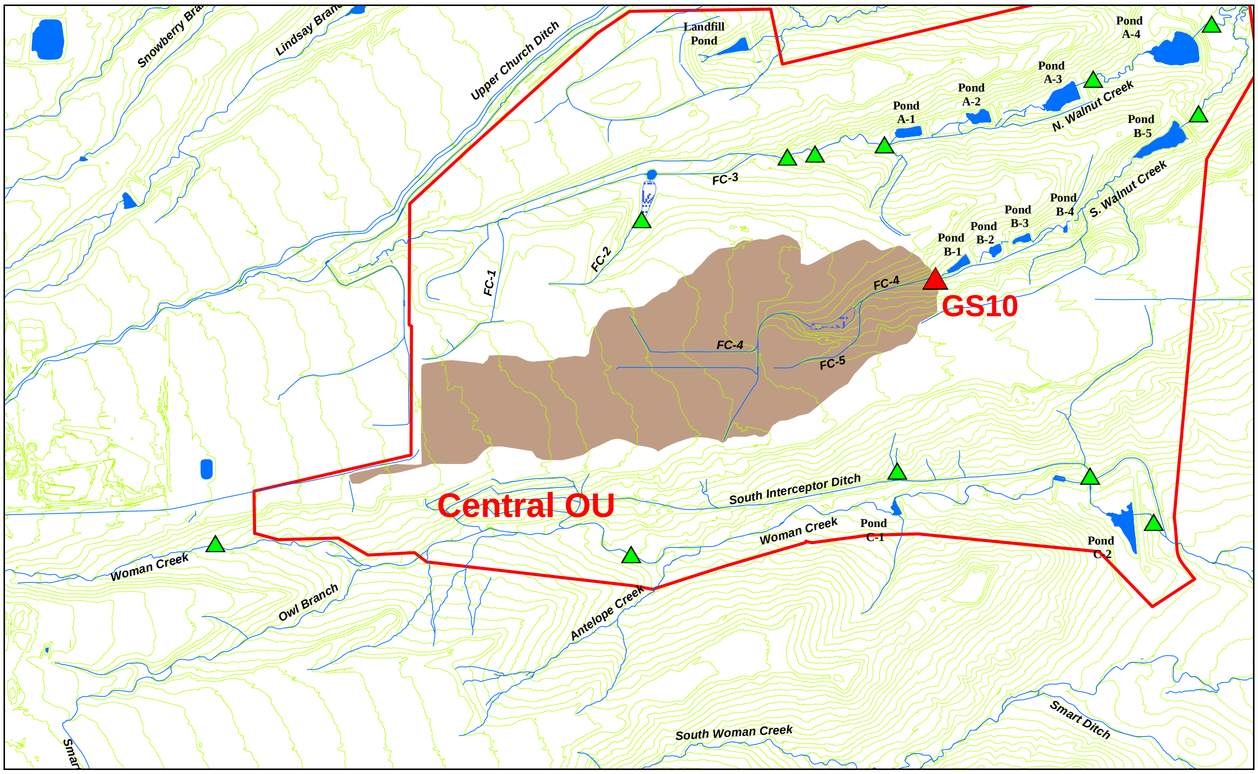



*Figure 3-65. GS10 Drainage Area*

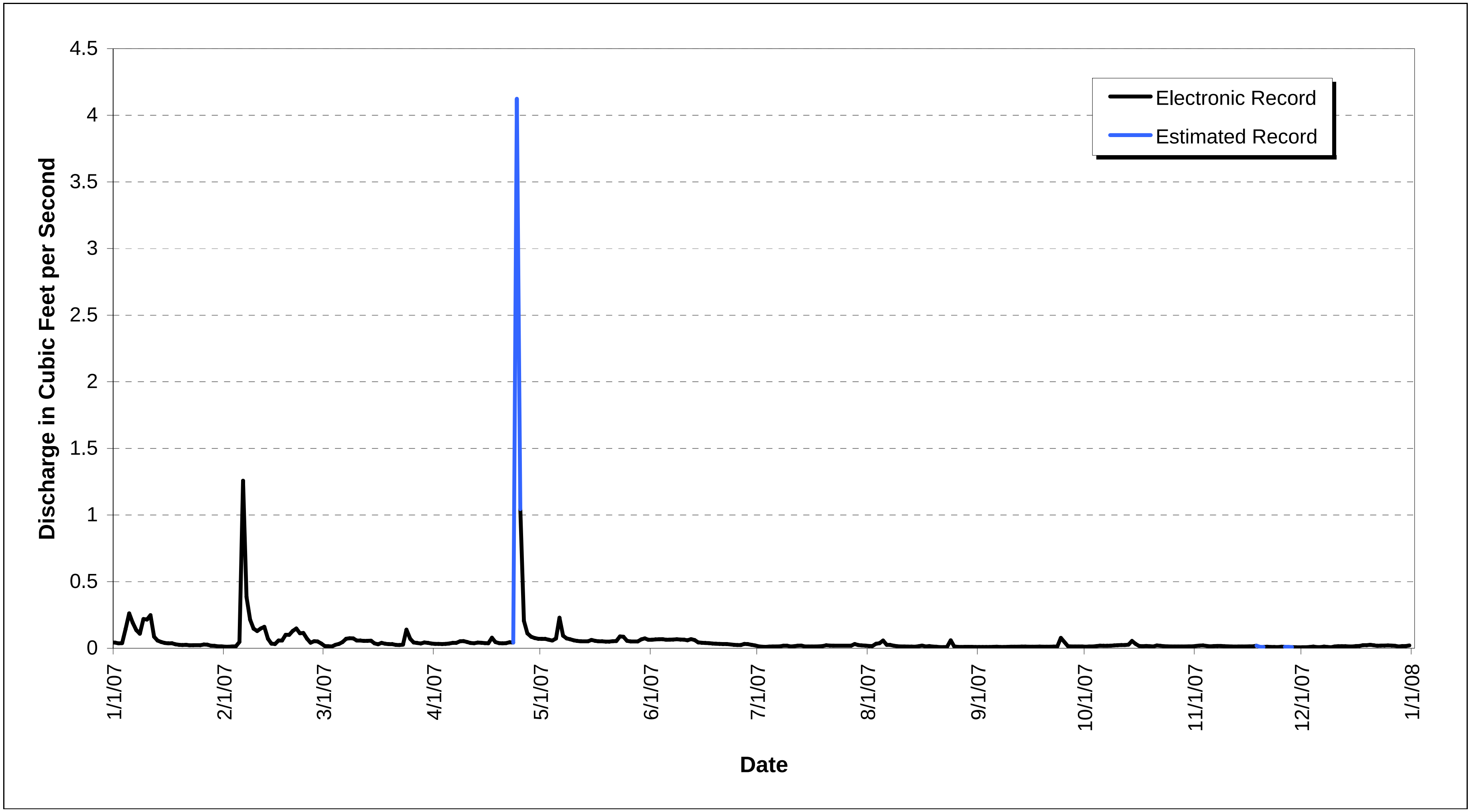



*Figure 3-66. CY 2007 Mean Daily Hydrograph at GS10: South Walnut Creek at Pond B-1 Bypass*

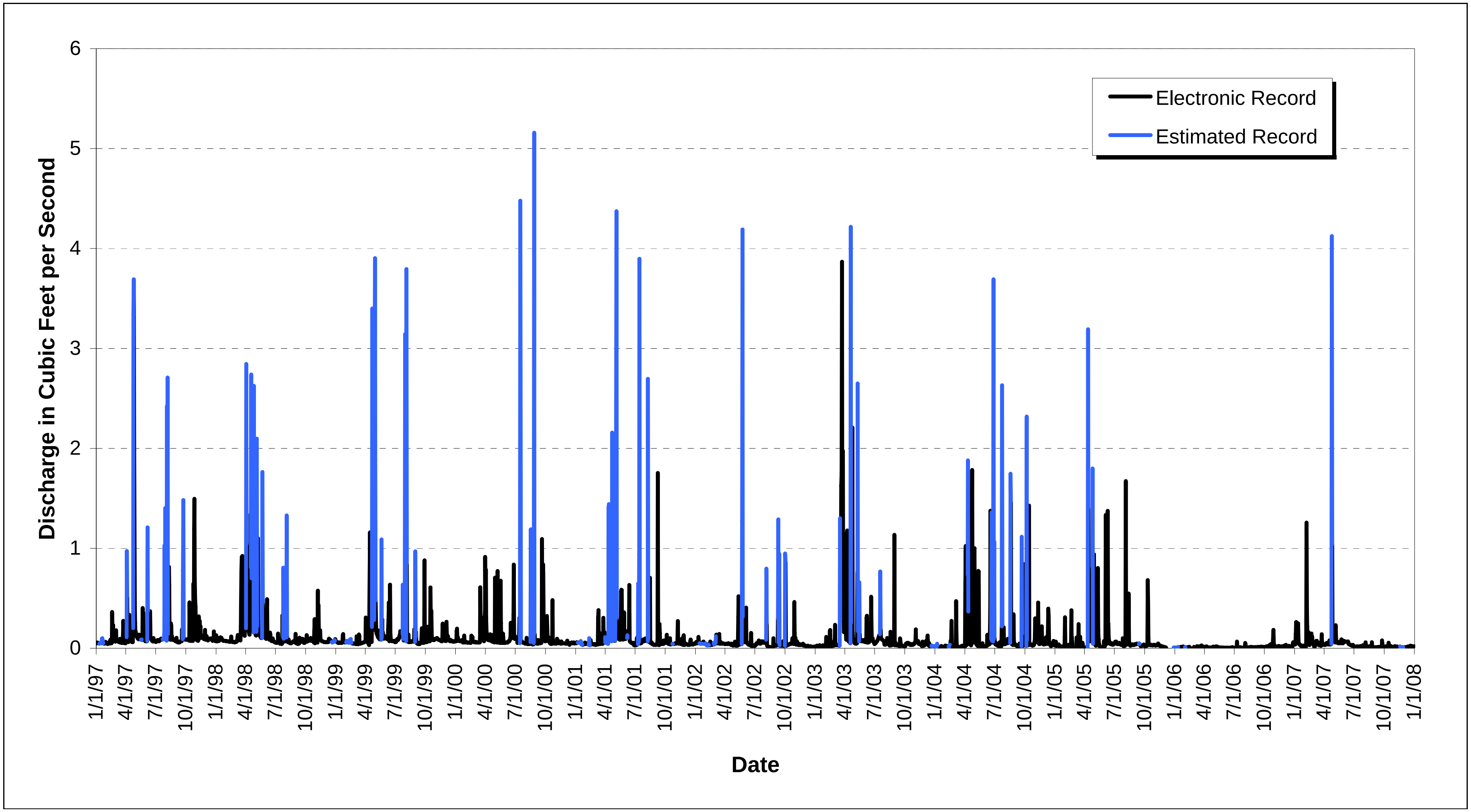



*Figure 3-67. CY 1997−2007 Mean Daily Hydrograph at GS10: South Walnut Creek at Pond B-1 Bypass*

*GS11: North Walnut Creek at Pond A-4 Outlet*

***Location***—North Walnut Creek at Pond A-4 outlet; State Plane: E2089930, N753265.

***Drainage Area***—The basin includes the North Walnut Creek drainage and northern portions of the COU (total of 395.0 acres).

***Period of Record***—May 12, 1992, to current year.

***Gage***—Water-stage recorder and 24-inch Parshall flume.

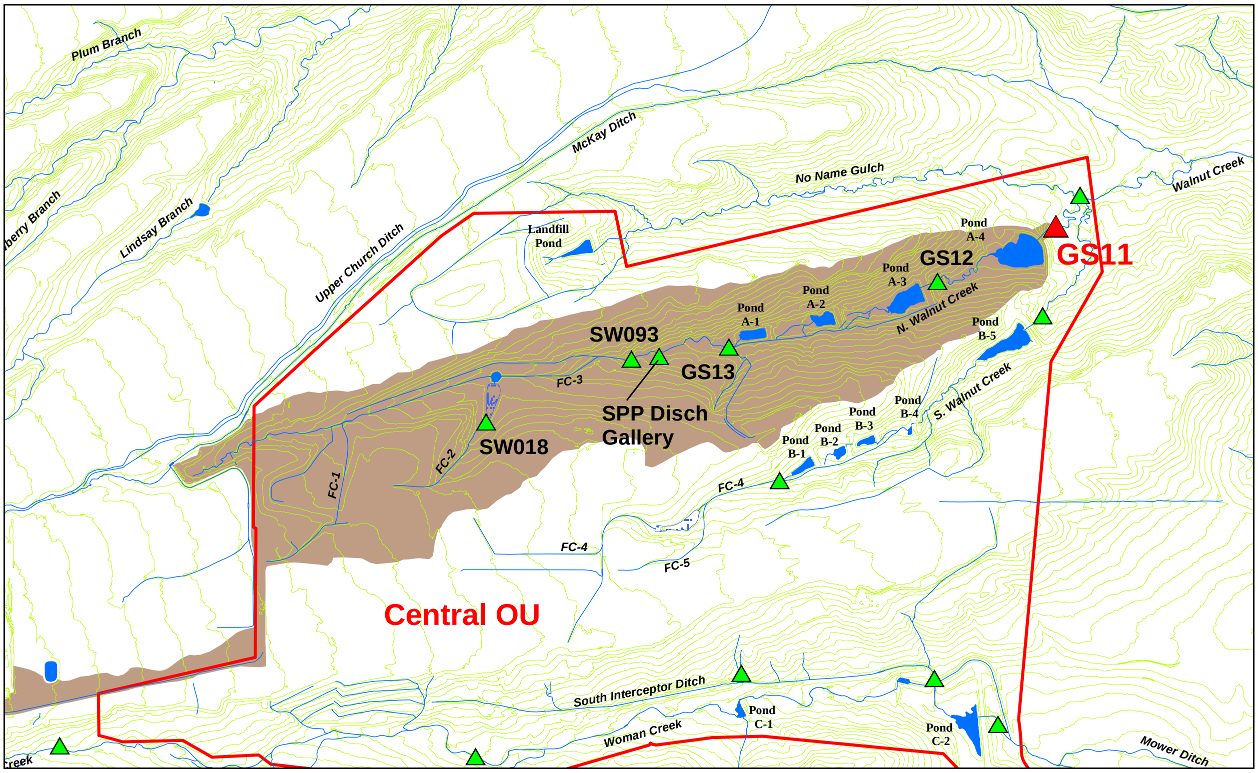



*Figure 3-68. GS11 Drainage Area*

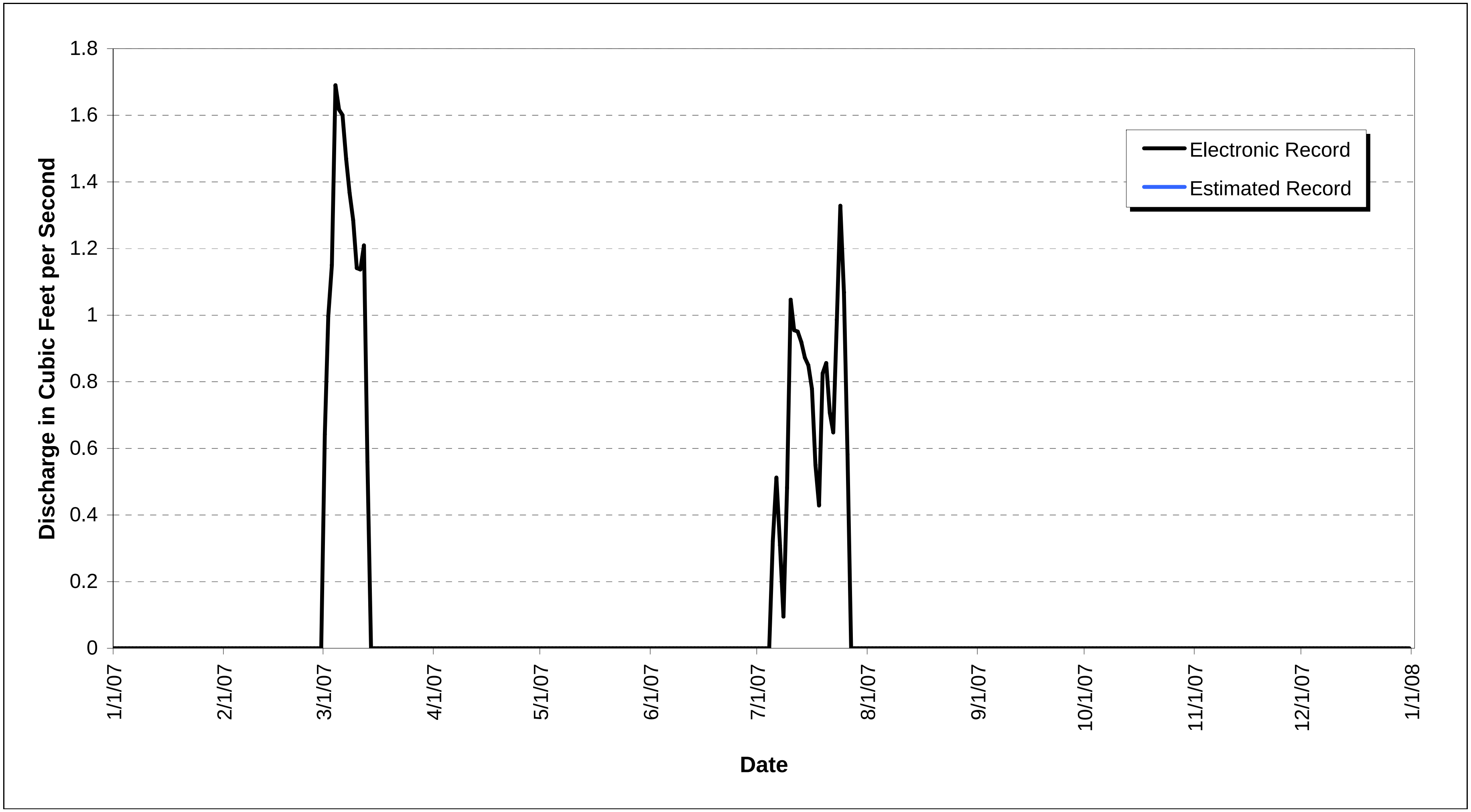



*Figure 3-69. CY 2007 Mean Daily Hydrograph at GS11: North Walnut Creek at Pond A-4 Outlet*

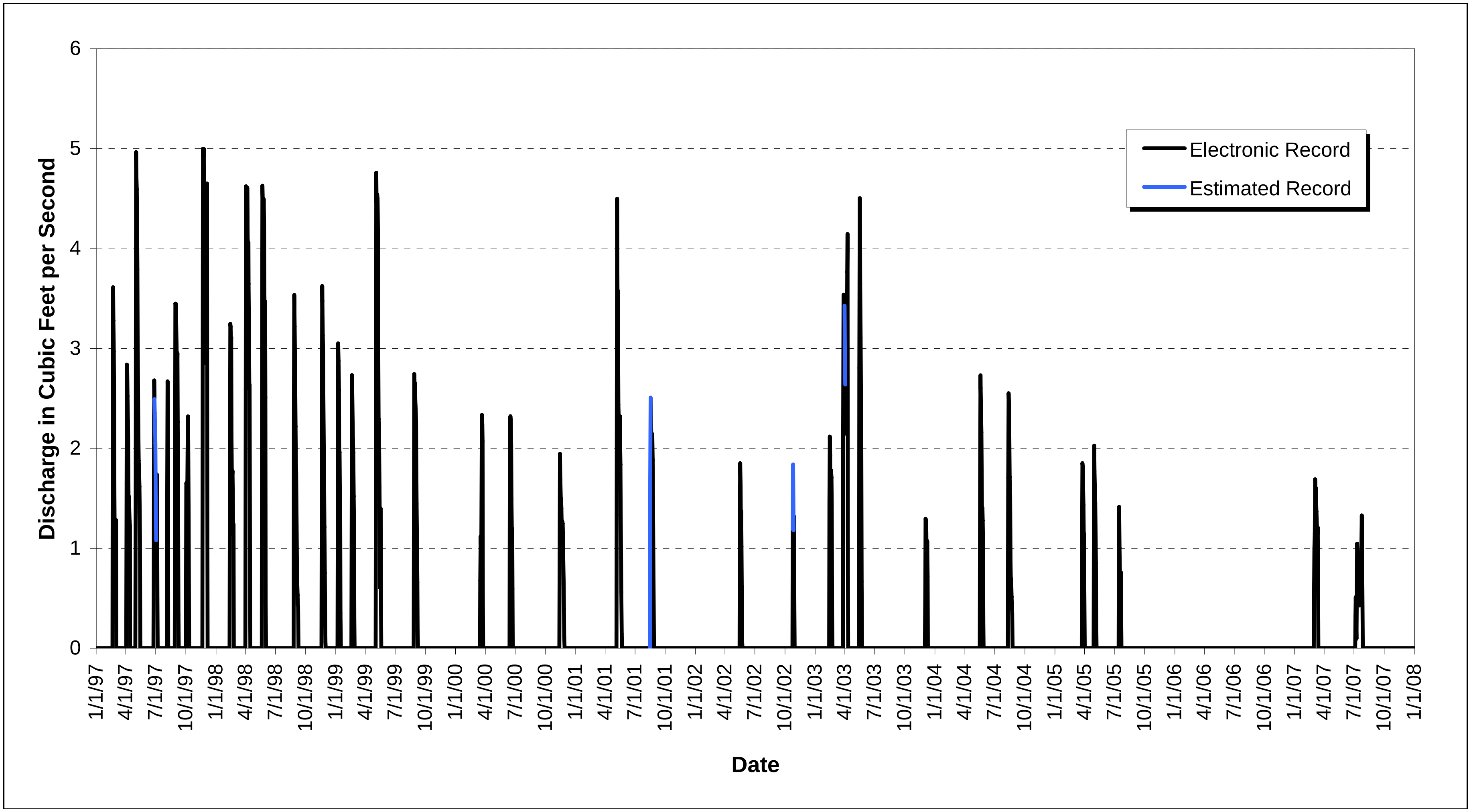



*Figure 3-70. CY 1997−2007 Mean Daily Hydrograph at GS11: North Walnut Creek at Pond A-4 Outlet*

*GS12: North Walnut Creek at Pond A-3 Outlet*

***Location***—North Walnut Creek at Pond A-3 outlet; State Plane: E2088564, N752629.

***Drainage Area***—The basin includes the North Walnut Creek drainage and northern portions of the COU (total of 361.7 acres).

***Period of Record***—May 13, 1992, to current year.

***Gage***—Water-stage recorder and 30-inch Parshall flume.

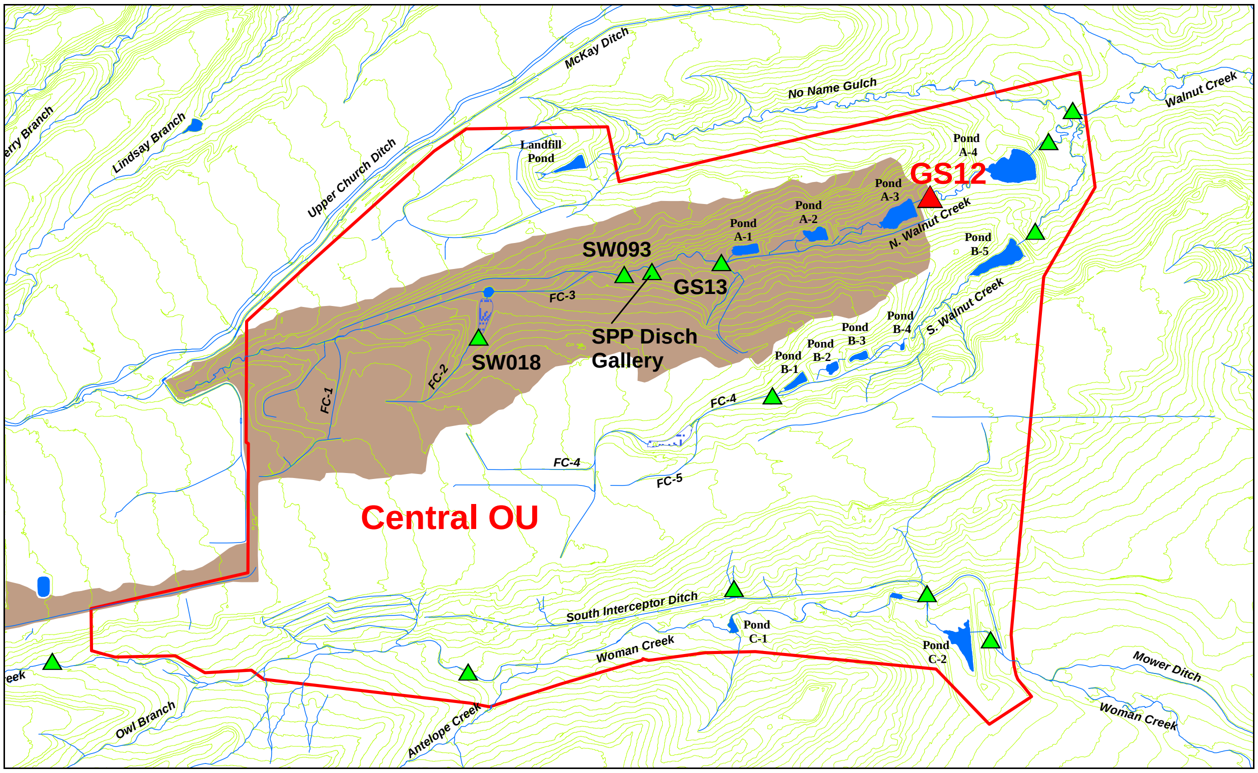



*Figure 3-71. GS12 Drainage Area*

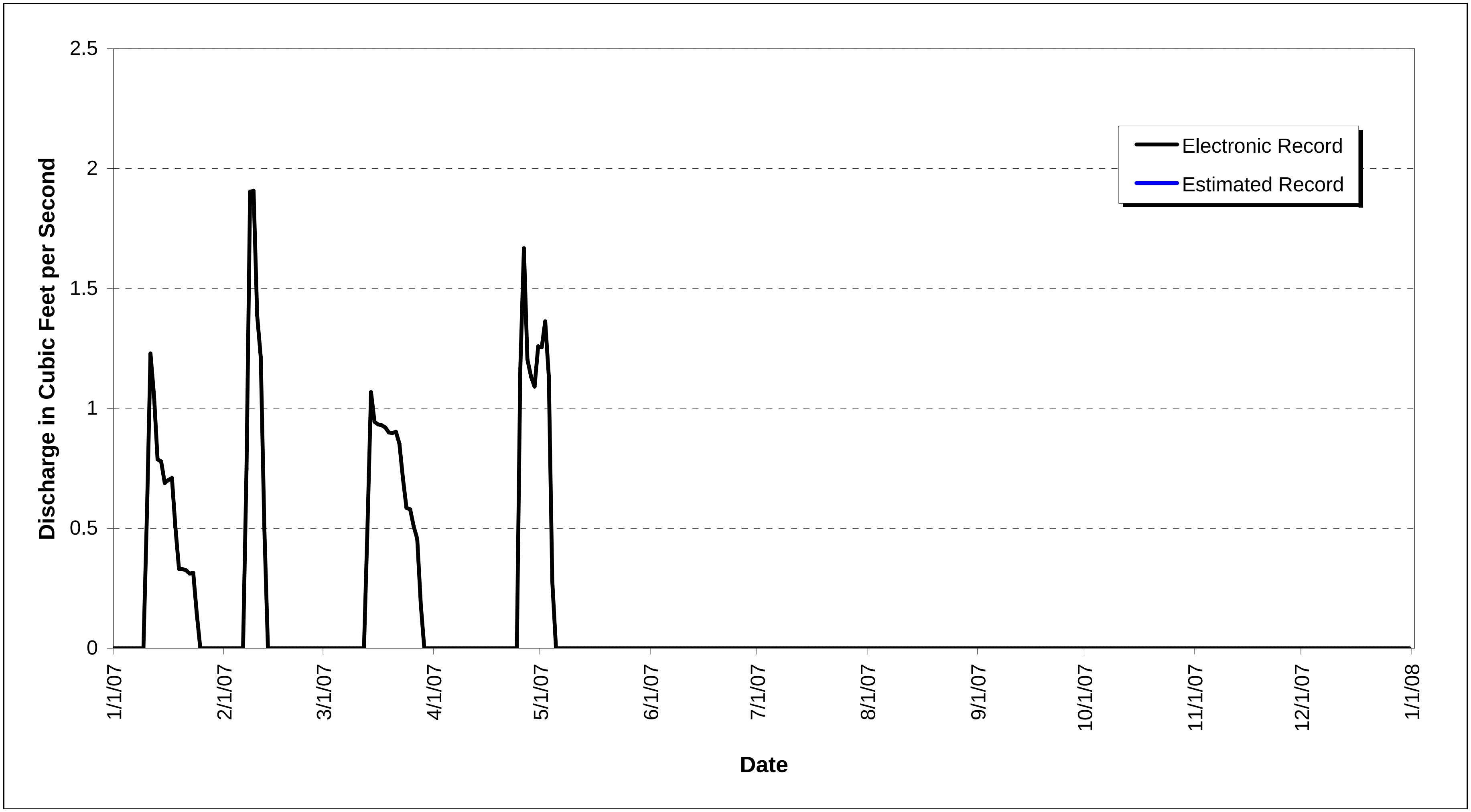



*Figure 3-72. CY 2007 Mean Daily Hydrograph at GS12: North Walnut Creek at Pond A-3 Outlet*

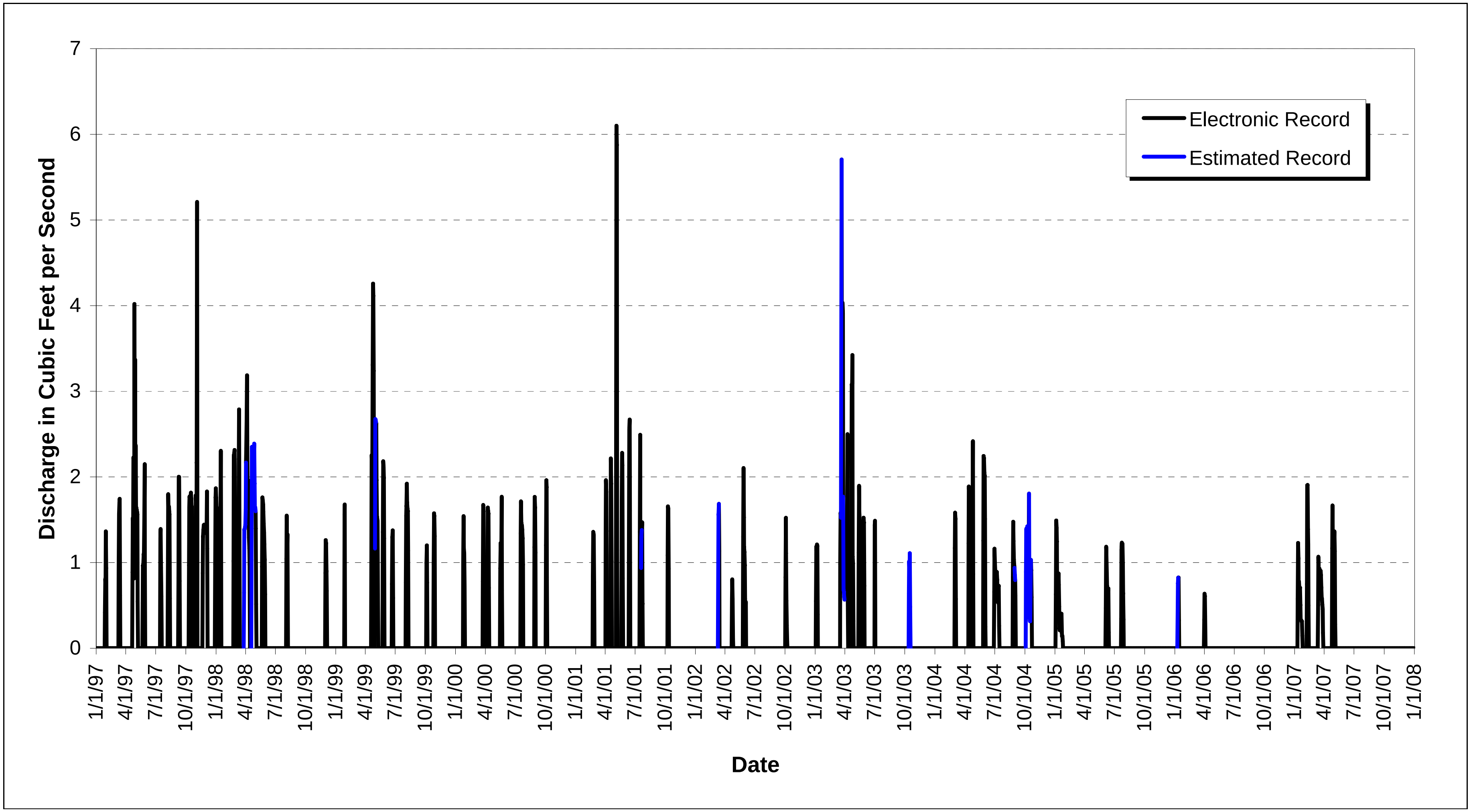



*Figure 3-73. CY 1997−2007 Mean Daily Hydrograph at GS12: North Walnut Creek at Pond A-3 Outlet*

***GS13: North Walnut Creek at Pond A-1 Bypass***

***Location***—North Walnut Creek at A-1 Bypass; State Plane: E2086153, N751870.

***Drainage Area***—The basin includes the North Walnut Creek drainage and northwestern portions of the COU (total of 260.8 acres).

***Period of Record***—October 1, 2005, to current year.

***Gage***—Water-stage recorder and 6-inch Parshall flume.

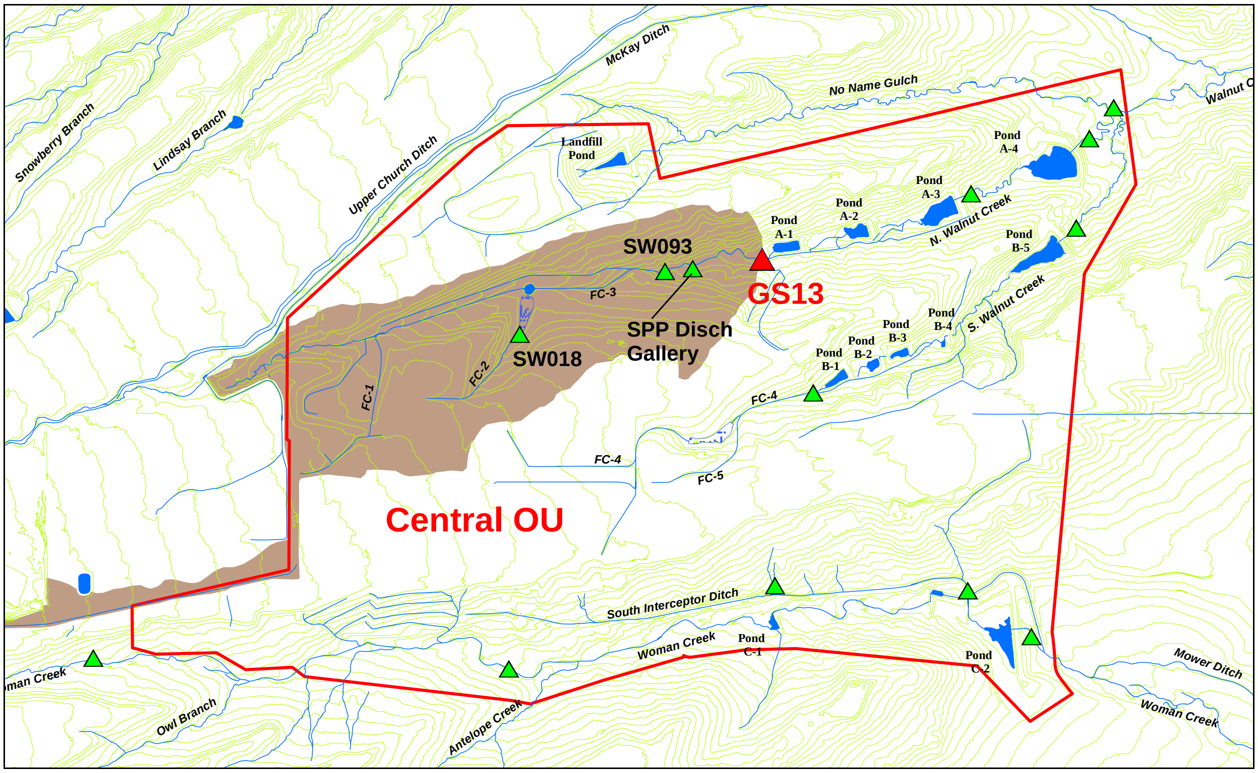



*Figure 3-74. GS13 Drainage Area*

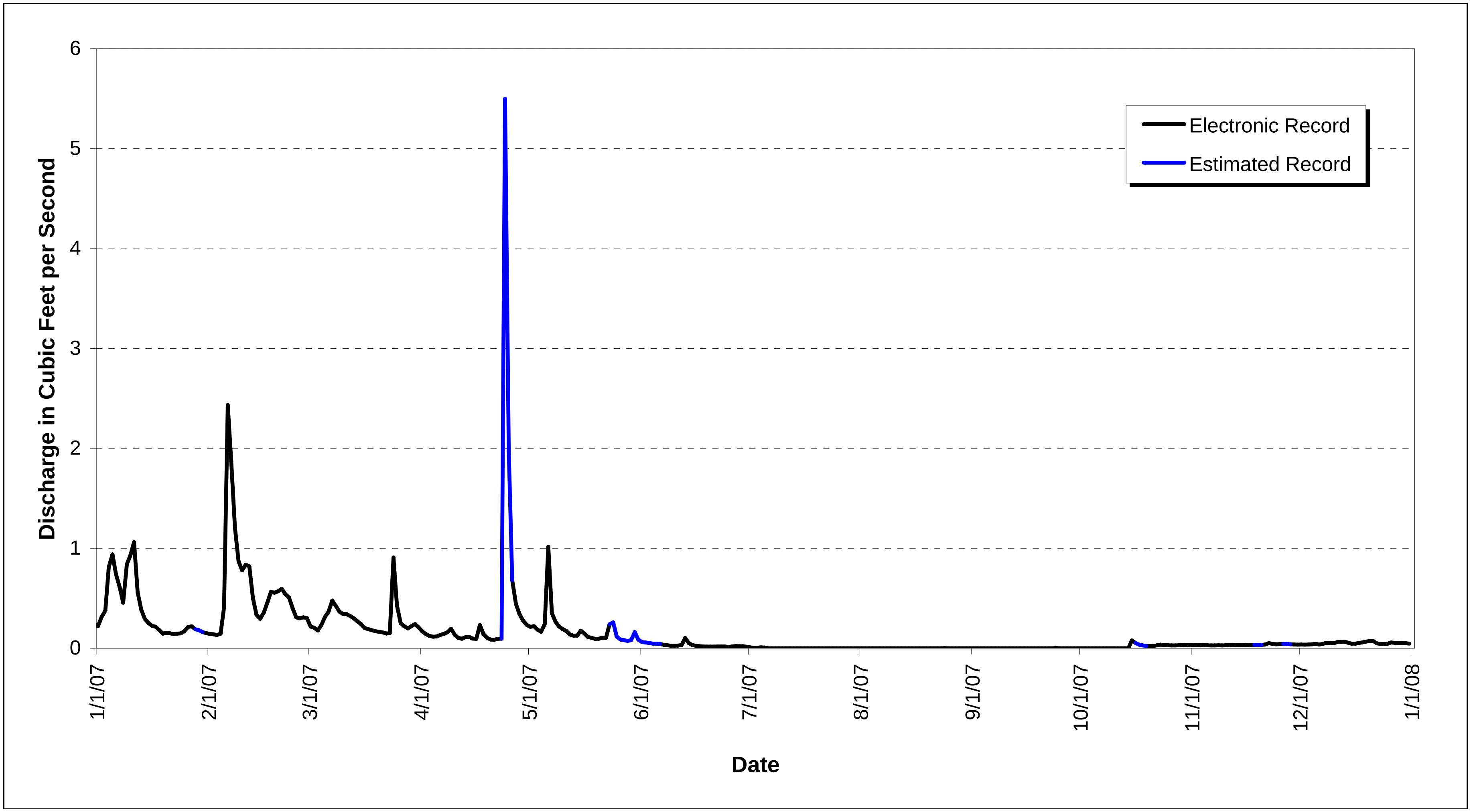



*Figure 3-75. CY 2007 Mean Daily Hydrograph at GS13: North Walnut Creek at Pond A-1 Bypass*

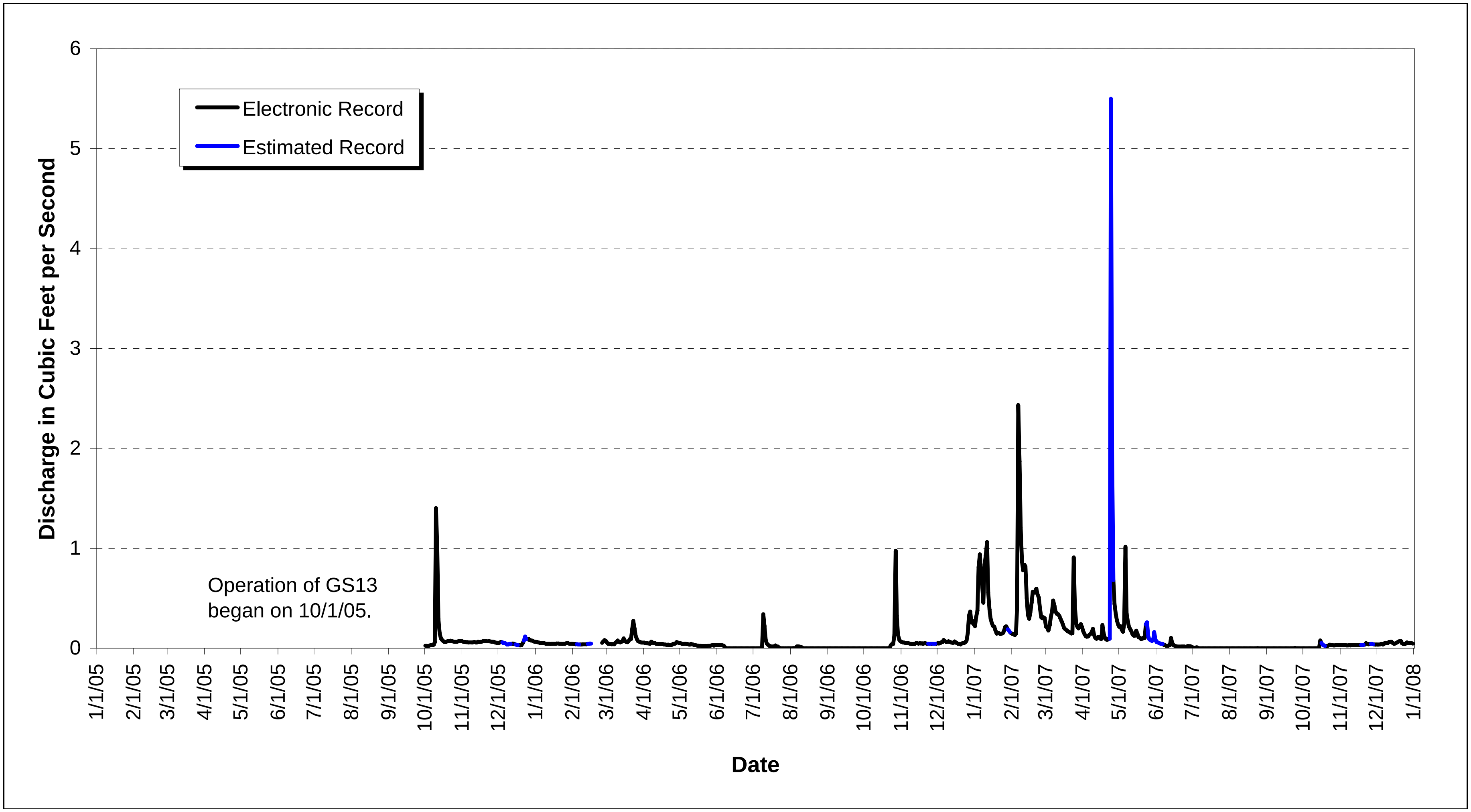



*Figure 3-76. CY 2005−2007 Mean Daily Hydrograph at GS13: North Walnut Creek at Pond A-1 Bypass*

*GS31: Woman Creek at Pond C-2 Outlet*

***Location***—Pond C-2 outlet; State Plane: E2089261, N747512.

***Drainage Area***—The basin includes a portion of the southern COU draining to the SID and the area surrounding Pond C-2 (total of 204.1 acres).

***Period of Record***—October 1, 1996, to current year.

***Gage***—Water-stage recorder and 24-inch Parshall flume.

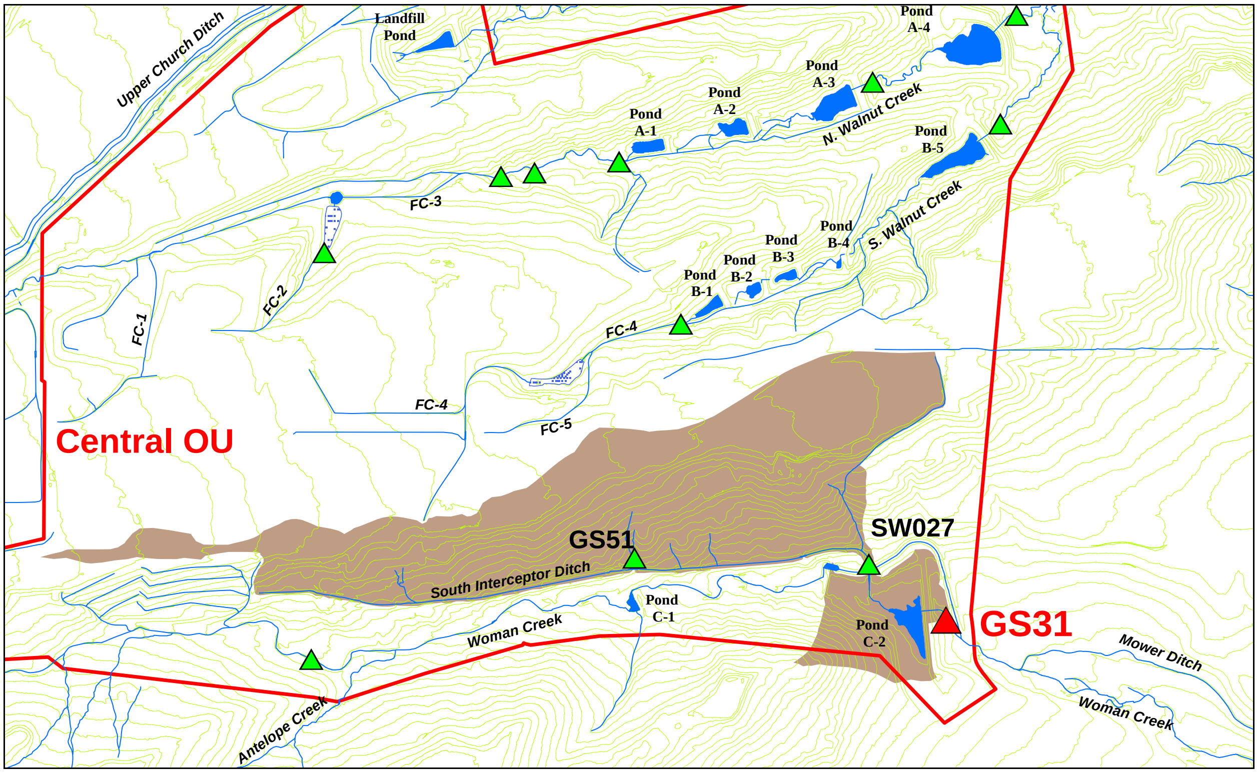



*Figure 3-77. GS31 Drainage Area*

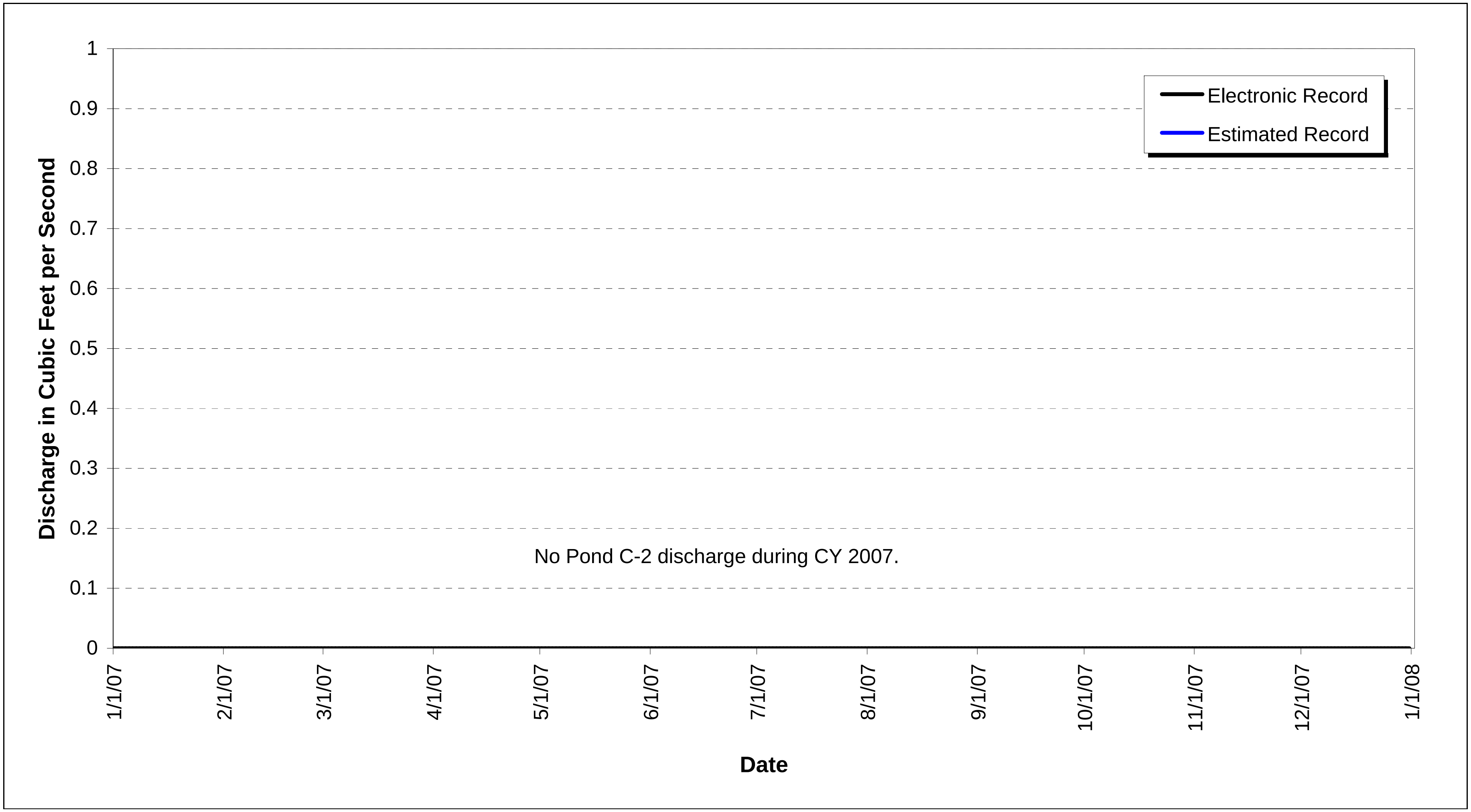



*Figure 3-78. CY 2007 Mean Daily Hydrograph at GS31: Woman Creek at Pond C-2 Outlet*

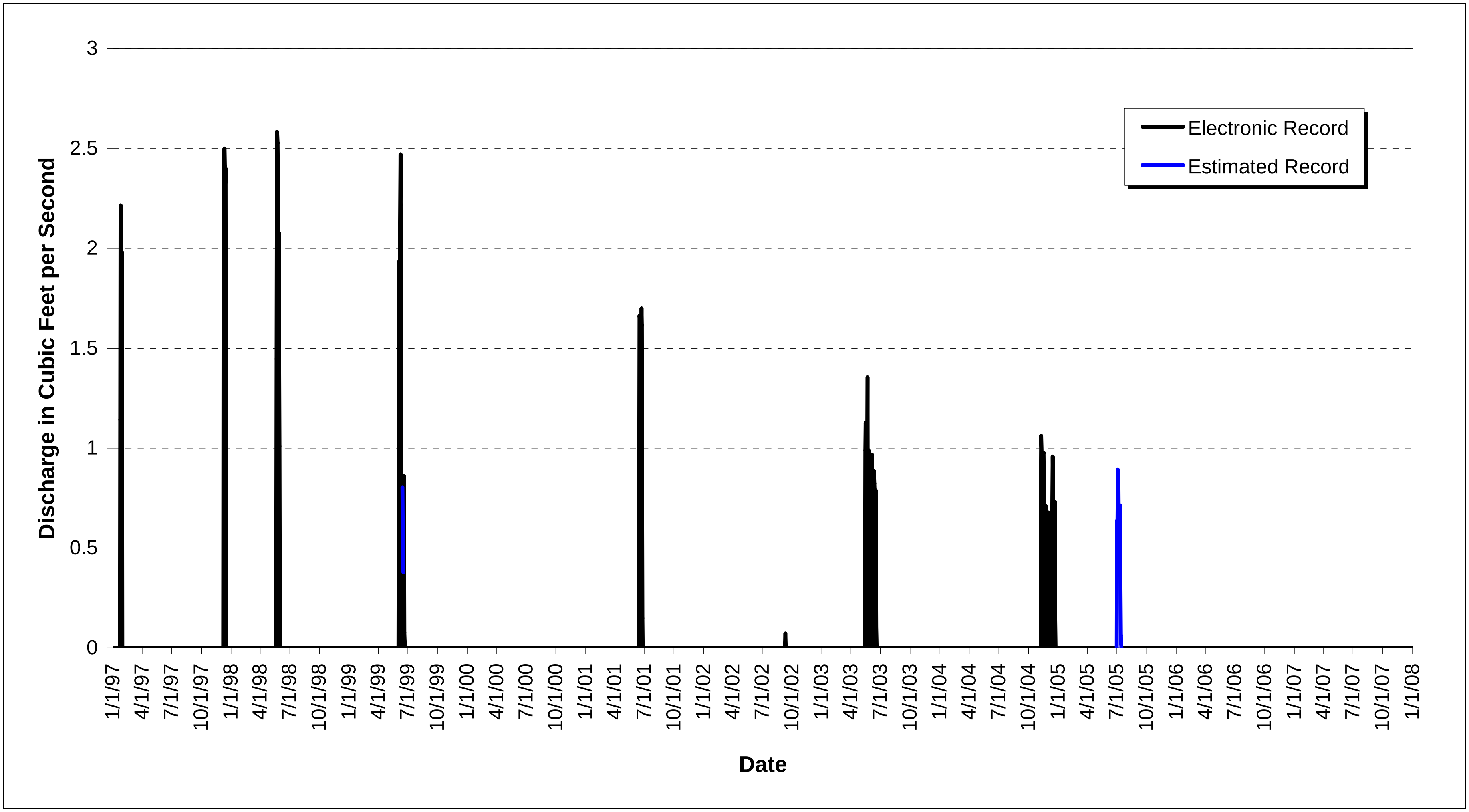



*Figure 3-79. CY 1997−2007 Mean Daily Hydrograph at GS31: Woman Creek at Pond C-2 Outlet*

***GS33: No Name Gulch at Walnut Creek***

***Location***—No Name Gulch at Walnut Creek; State Plane: E2090210, N753623.

***Drainage Area***—The basin is the No Name Gulch drainage (total of 295.3 acres).

***Period of Record***—September 16, 1997, to current year.

***Gage***—Water-stage recorder and 9.5-inch Parshall flume.

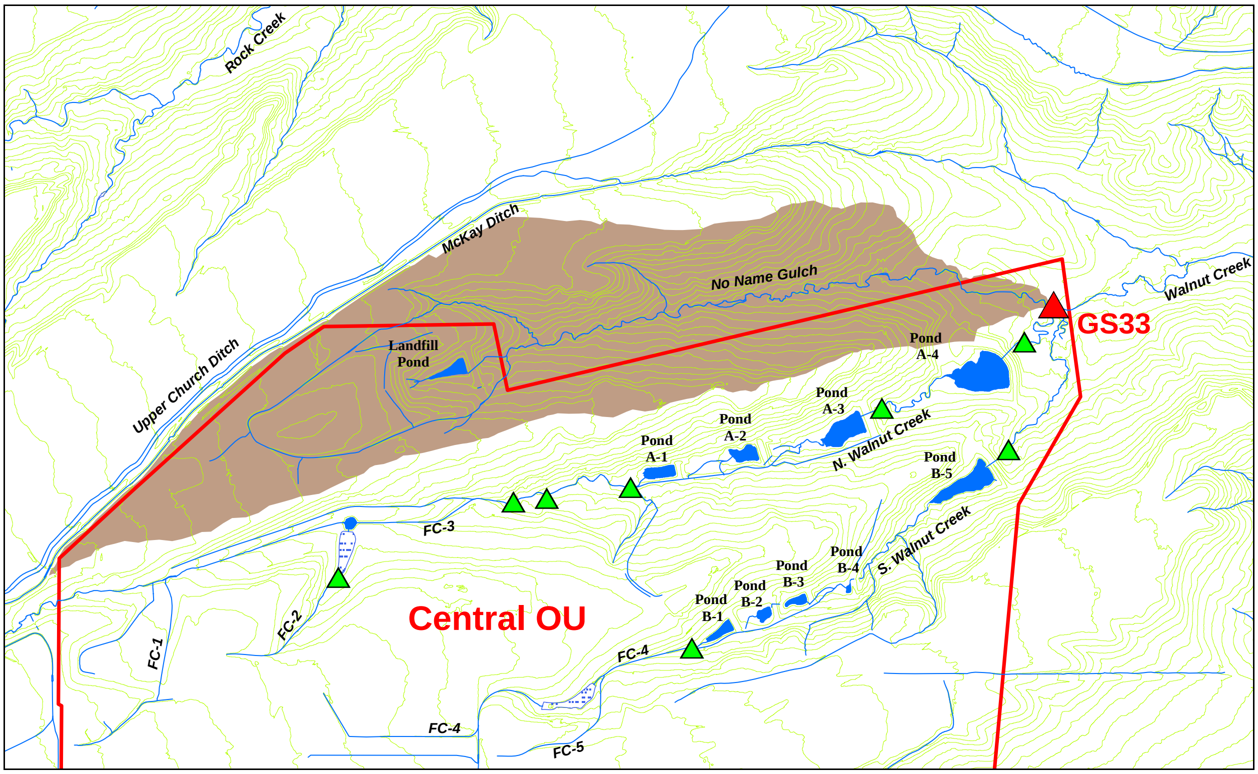



*Figure 3-80. GS33 Drainage Area*

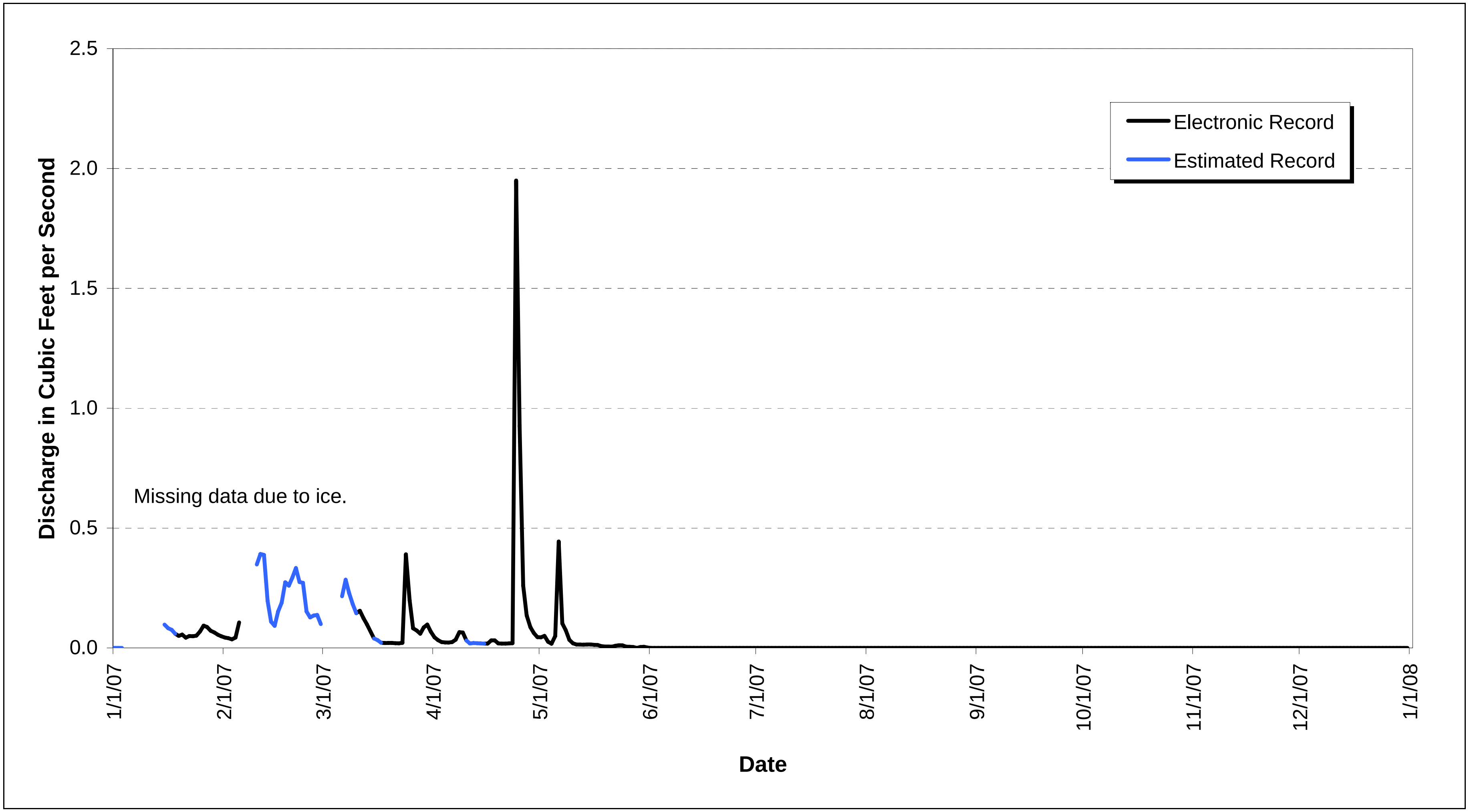



*Figure 3-81. CY 2007 Mean Daily Hydrograph at GS33: No Name Gulch at Walnut Creek*

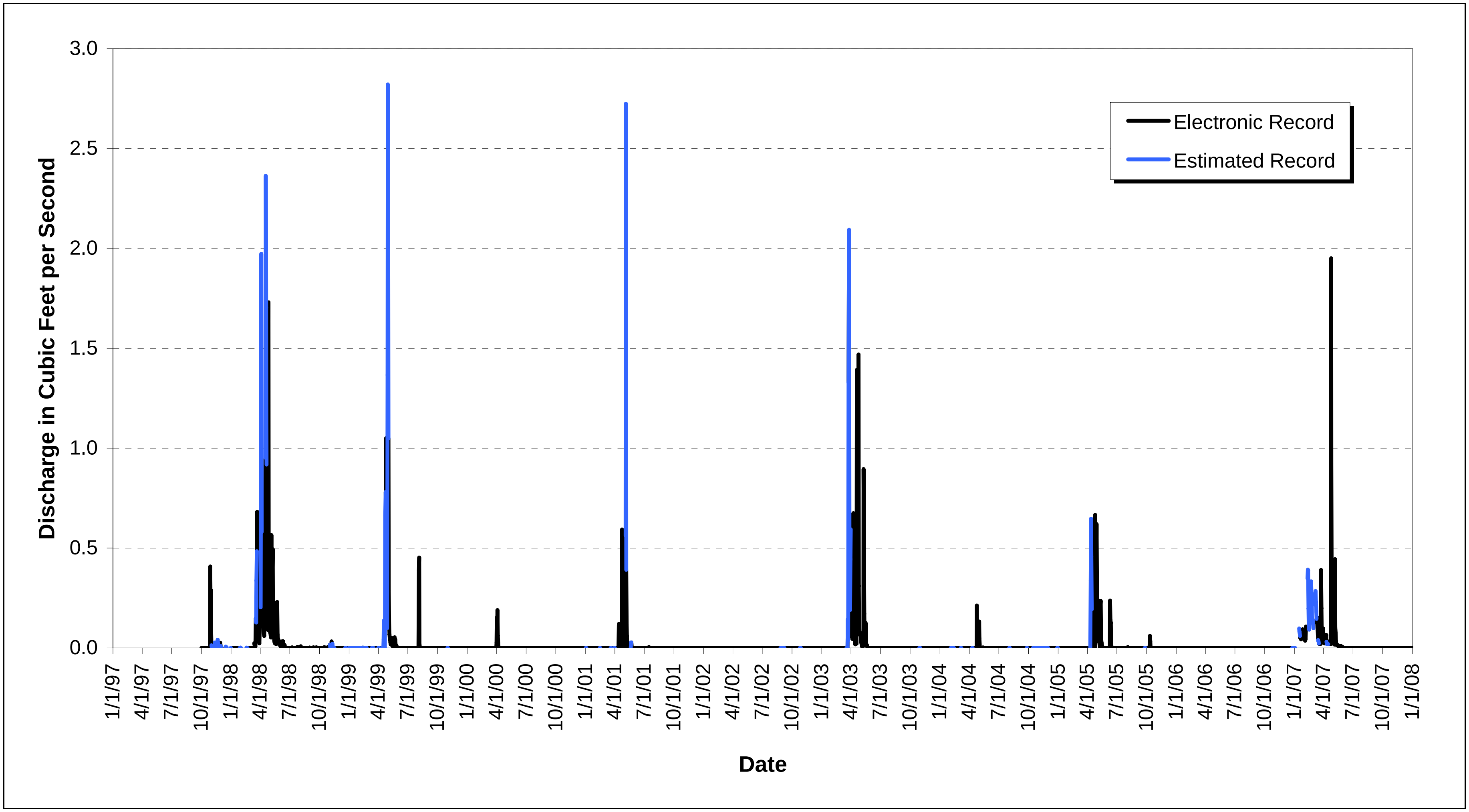



*Figure 3-82. CY 1997−2007 Mean Daily Hydrograph at GS33: No Name Gulch at Walnut Creek*

### *GS51: Ditch South of 903 Pad*

***Location***—Ditch south of 903 Pad; State Plane: E2086300, N748102.

***Drainage Area***—The basin includes an area south and west of the former 903 Pad (total of 16.0 acres).

***Period of Record***—August 13, 2001, to current year.

***Gage***—Water-stage recorder and 0.75-foot H-flume.

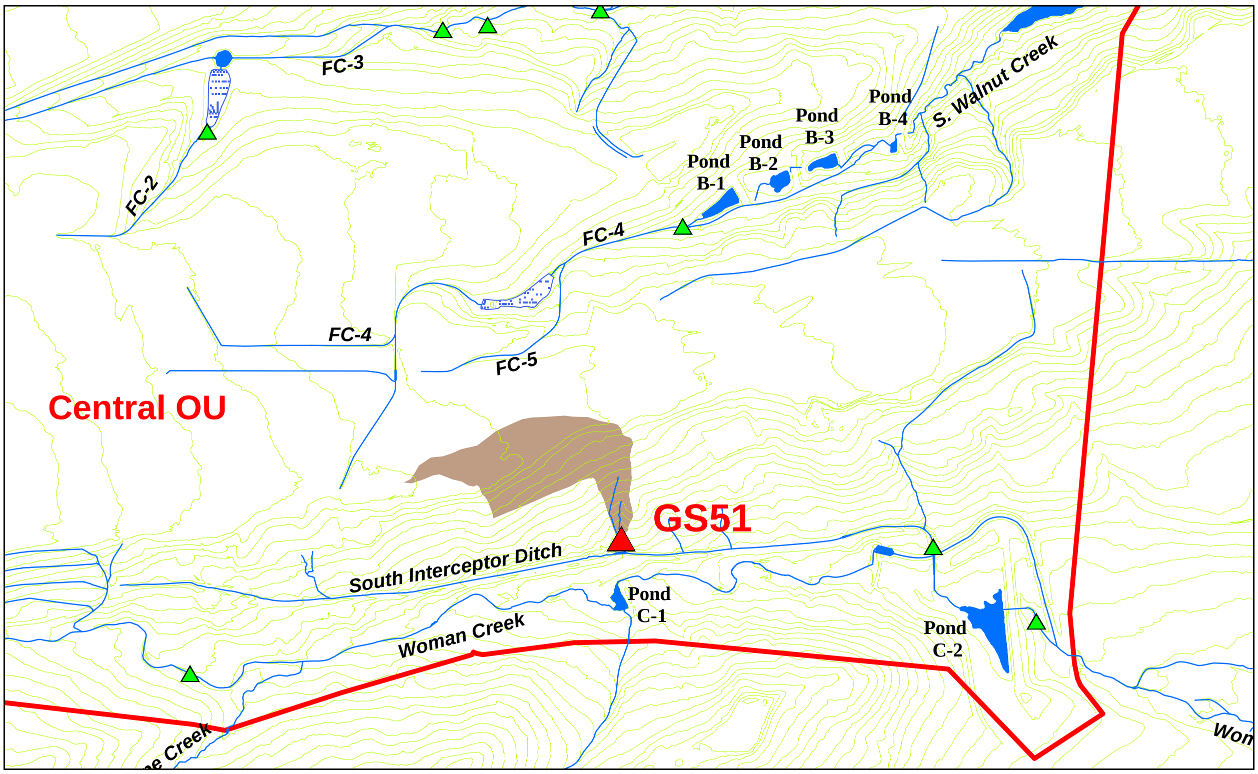



*Figure 3-83. GS51 Drainage Area*

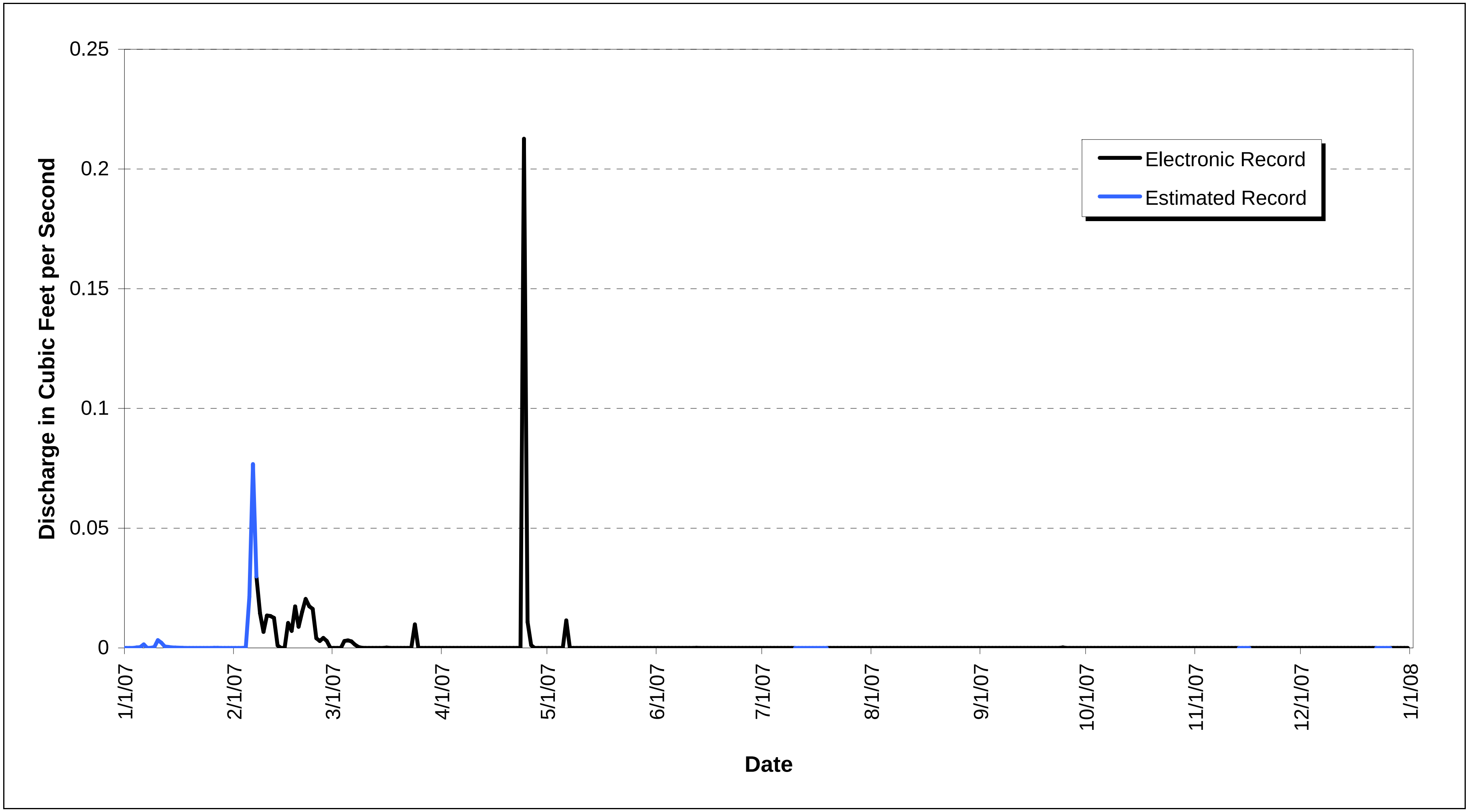



*Figure 3-84. CY 2007 Mean Daily Hydrograph at GS51: Ditch South of 903 Pad*

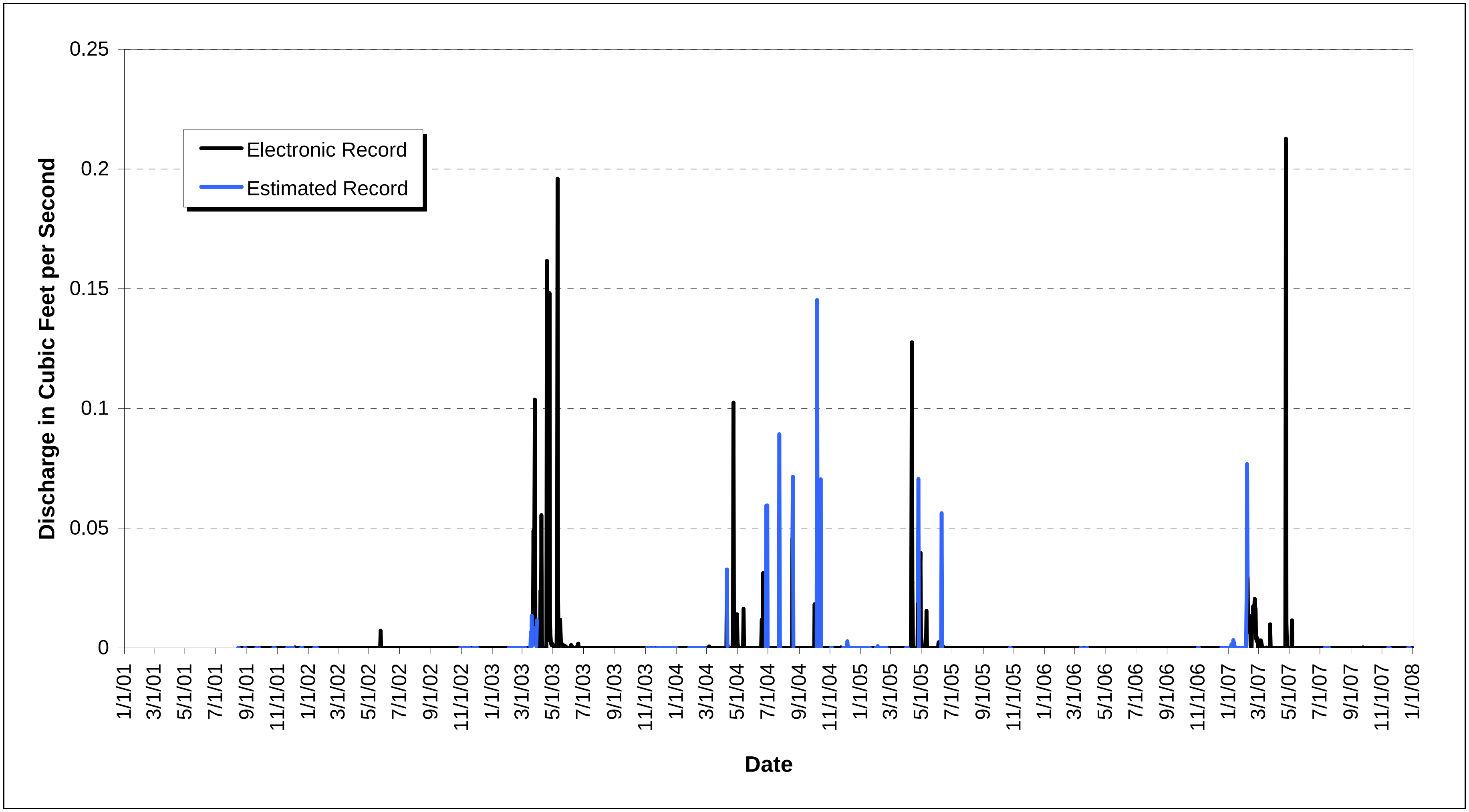



*Figure 3-85. CY 2001−2007 Mean Daily Hydrograph at GS51: Ditch South of 903 Pad*

### *GS59: Woman Creek Upstream of Antelope Springs Confluence*

***Location***—Woman Creek 900 feet upstream of Antelope Springs confluence; State Plane: E2083228, N747139.

***Drainage Area***—The basin includes upstream reaches of Woman Creek; areas west of Highway 93 also contribute runoff (total drainage acreage undetermined).

***Period of Record***—November 20, 2002, to current year.

***Gage***—Water-stage recorder and 1.5-foot Parshall flume.

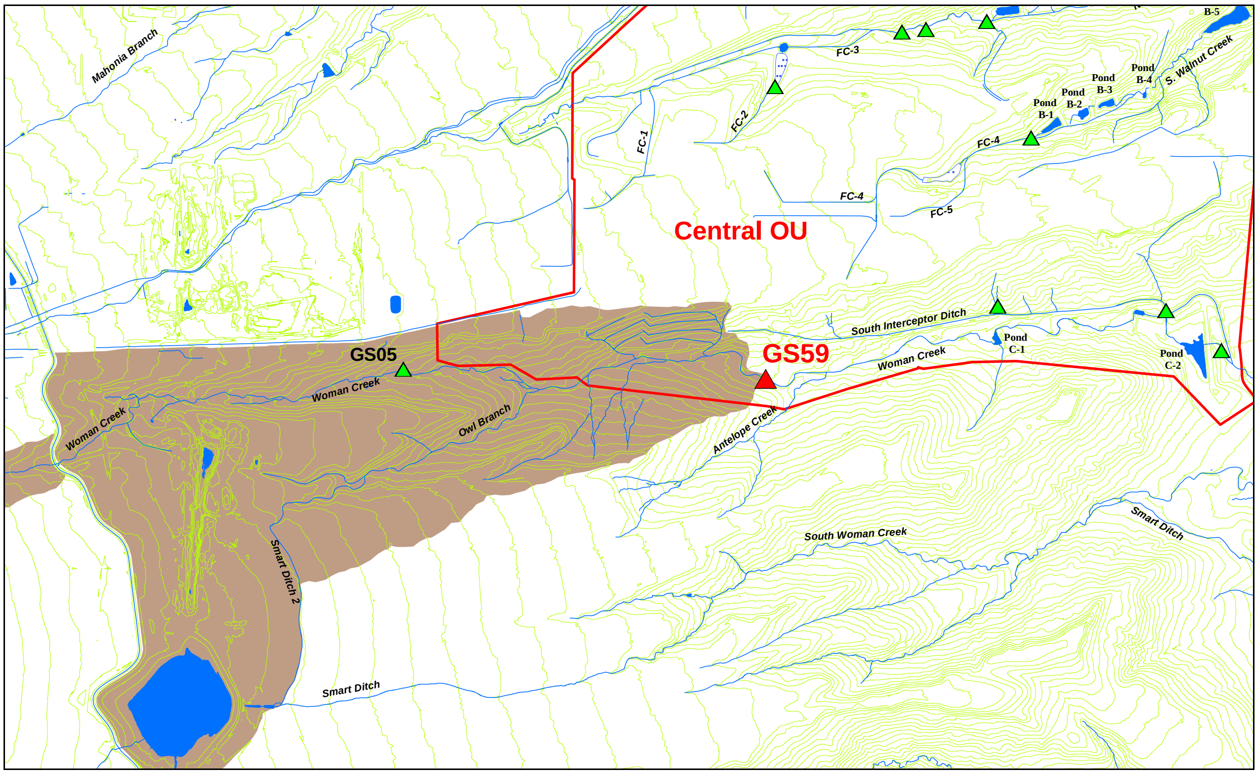



*Figure 3-86. GS59 Drainage Area*

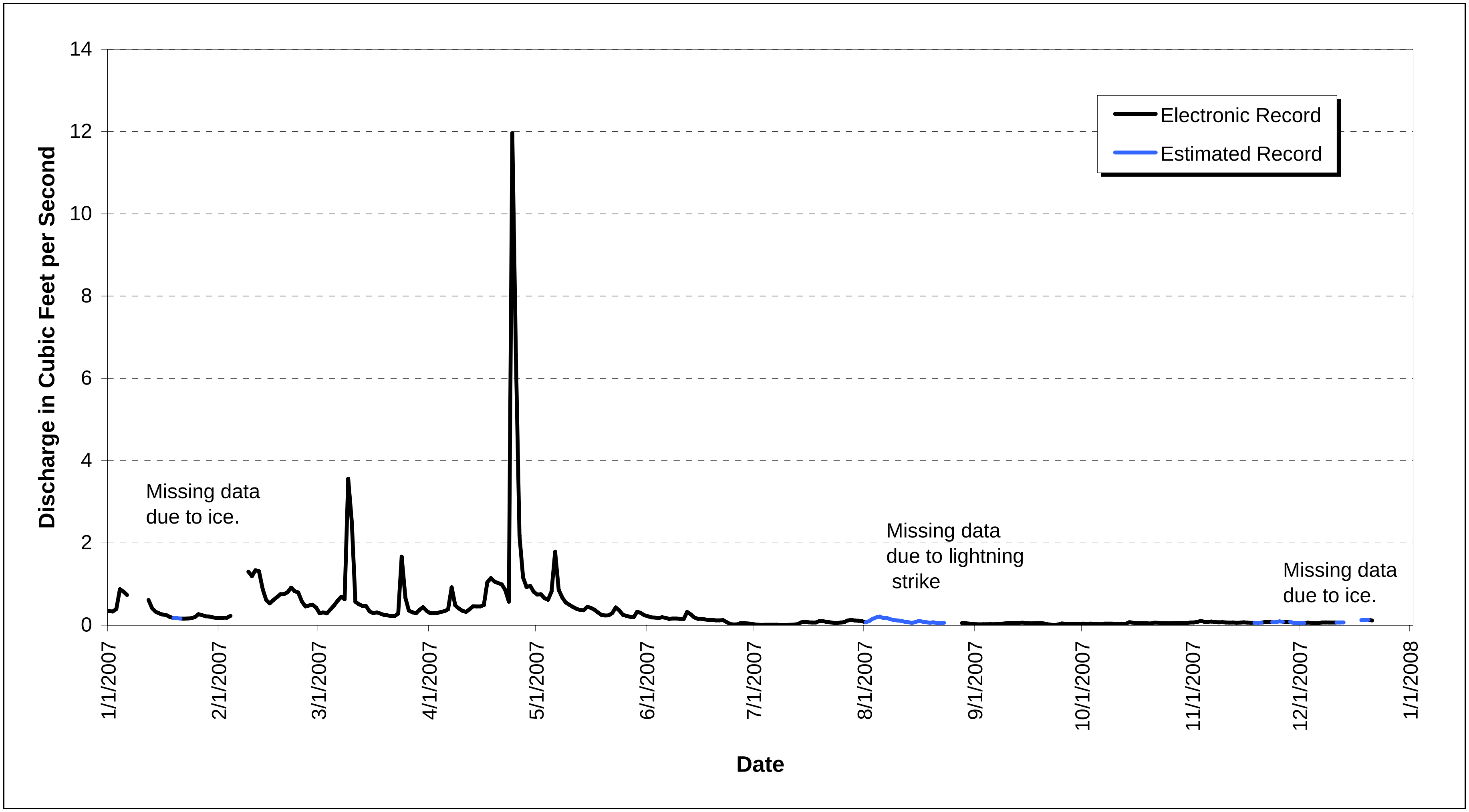



*Figure 3-87. CY 2007 Mean Daily Hydrograph at GS59: Woman Creek Upstream of Antelope Springs Confluence*

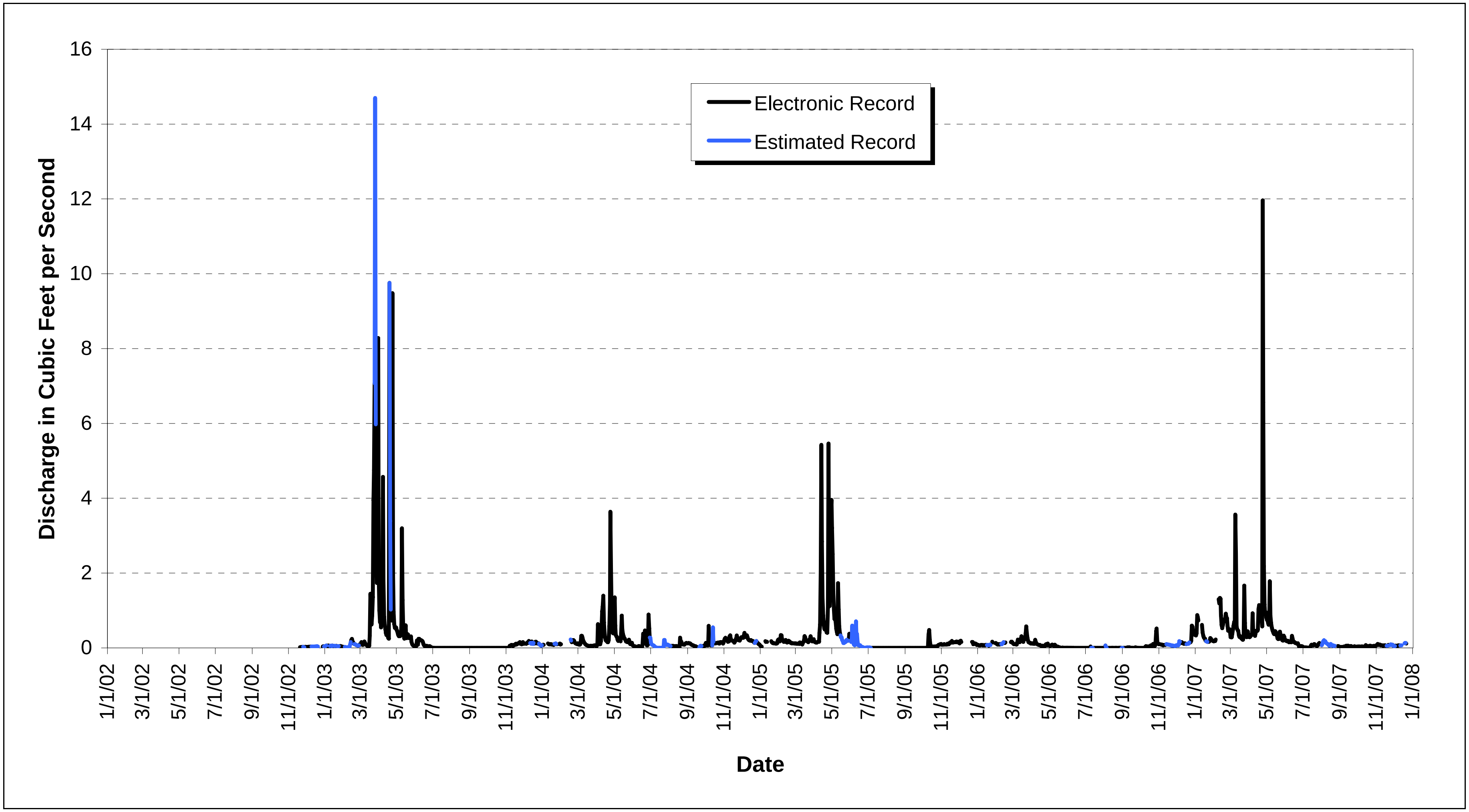



*Figure 3-88. CY 2002−2007 Mean Daily Hydrograph at GS59: Woman Creek Upstream of Antelope Springs Confluence*

### *SPPDISCHARGEGALLERY: SPPTS DG*

***Location***—SPPTS DG tributary to North Walnut Creek; State Plane: E2085350, N751764.

***Drainage Area***—Not applicable; the SPPDISCHARGEGALLERY receives effluent flow from the SPPTS.

***Period of Record***—April 10, 2007, to current year.

***Gage***—Water-stage recorder and 0.6-foot HS flume.

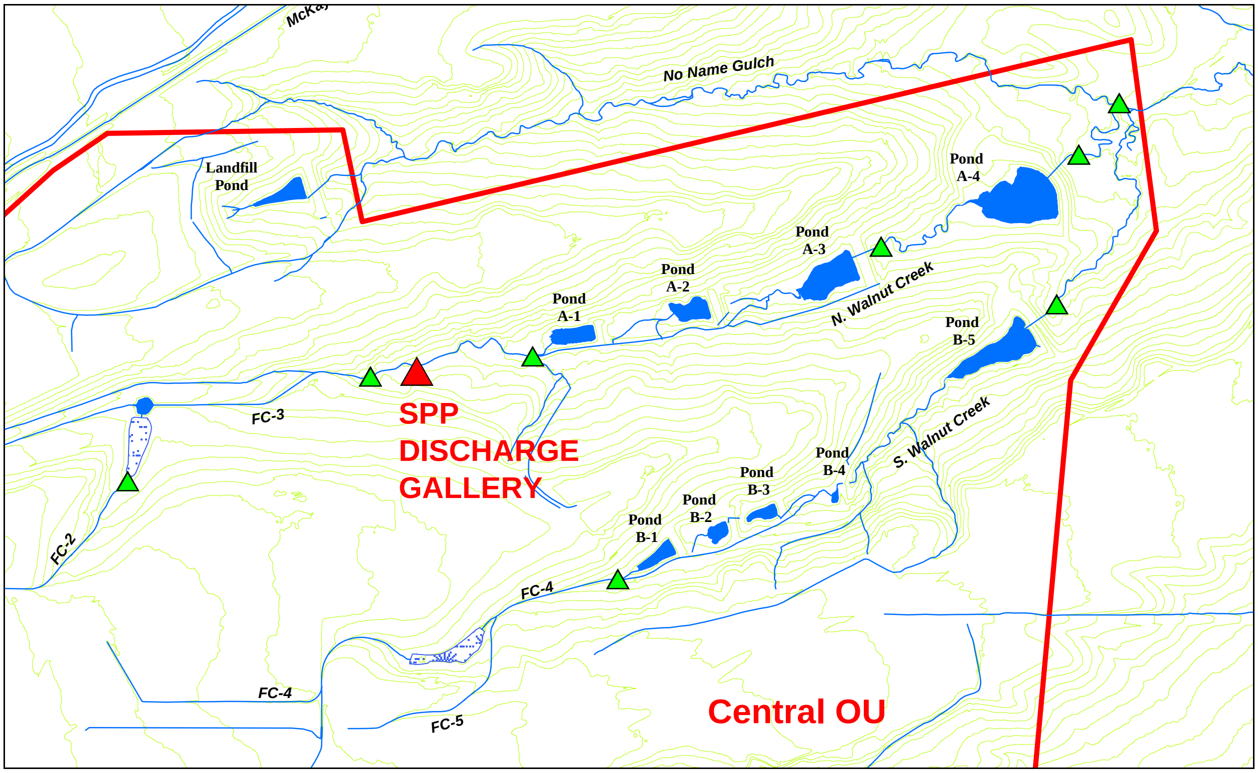



*Figure 3-89. SPPDISCHARGEGALLERY Location*

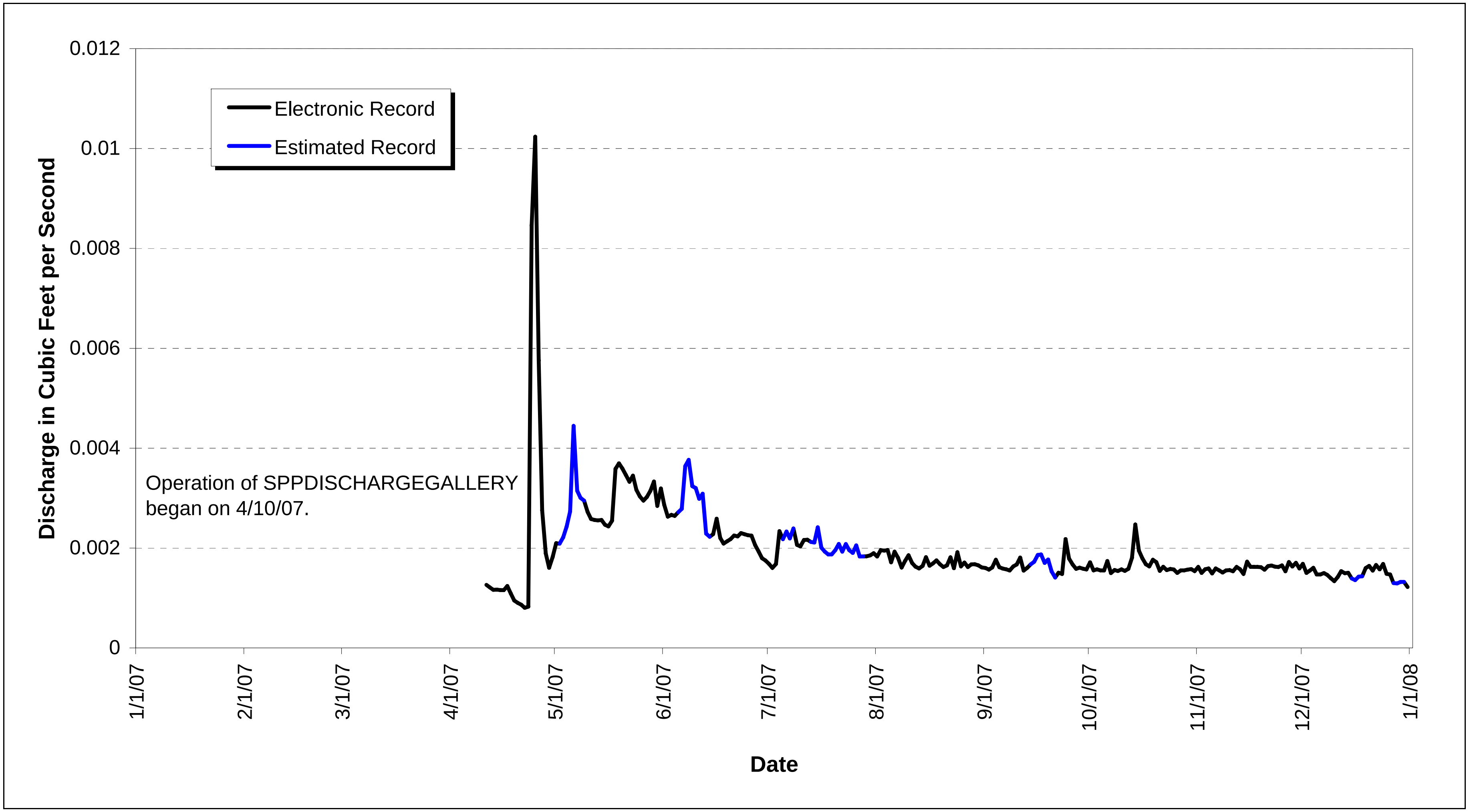



*Figure 3-90. CY 2006 Mean Daily Hydrograph at SPPDISCHARGEGALLERY*

### *SW018: FC-2 at FC-2 Wetland*

***Location***—FC-2 drainage just upstream of FC-2 wetland; State Plane: E2083351, N751006.

***Drainage Area***—The basin includes FC-2 areas tributary to North Walnut Creek (total of 42.4 acres).

***Period of Record***—October 10, 2003, to current year.

***Gage***—Water-stage recorder and 1-foot Parshall flume through September 12, 2006. One-foot H flume installed on September 13, 2006.

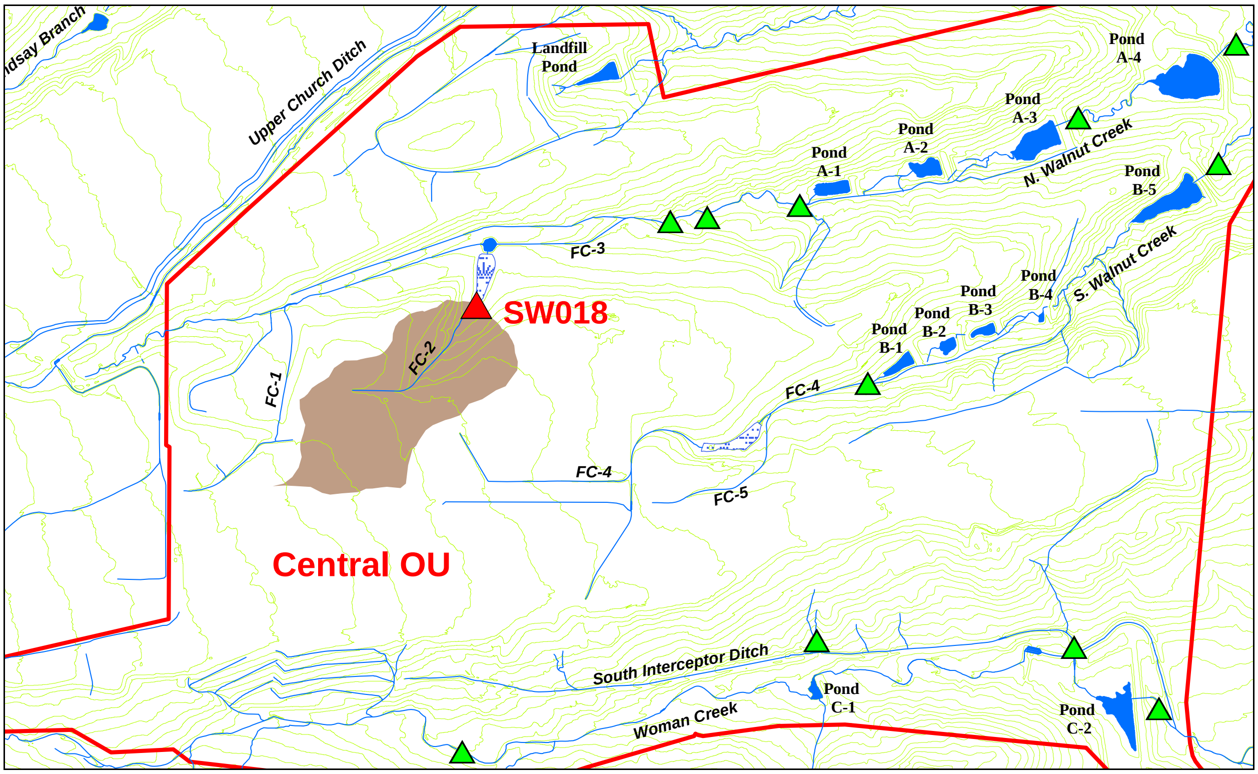



*Figure 3-91. SW018 Drainage Area*

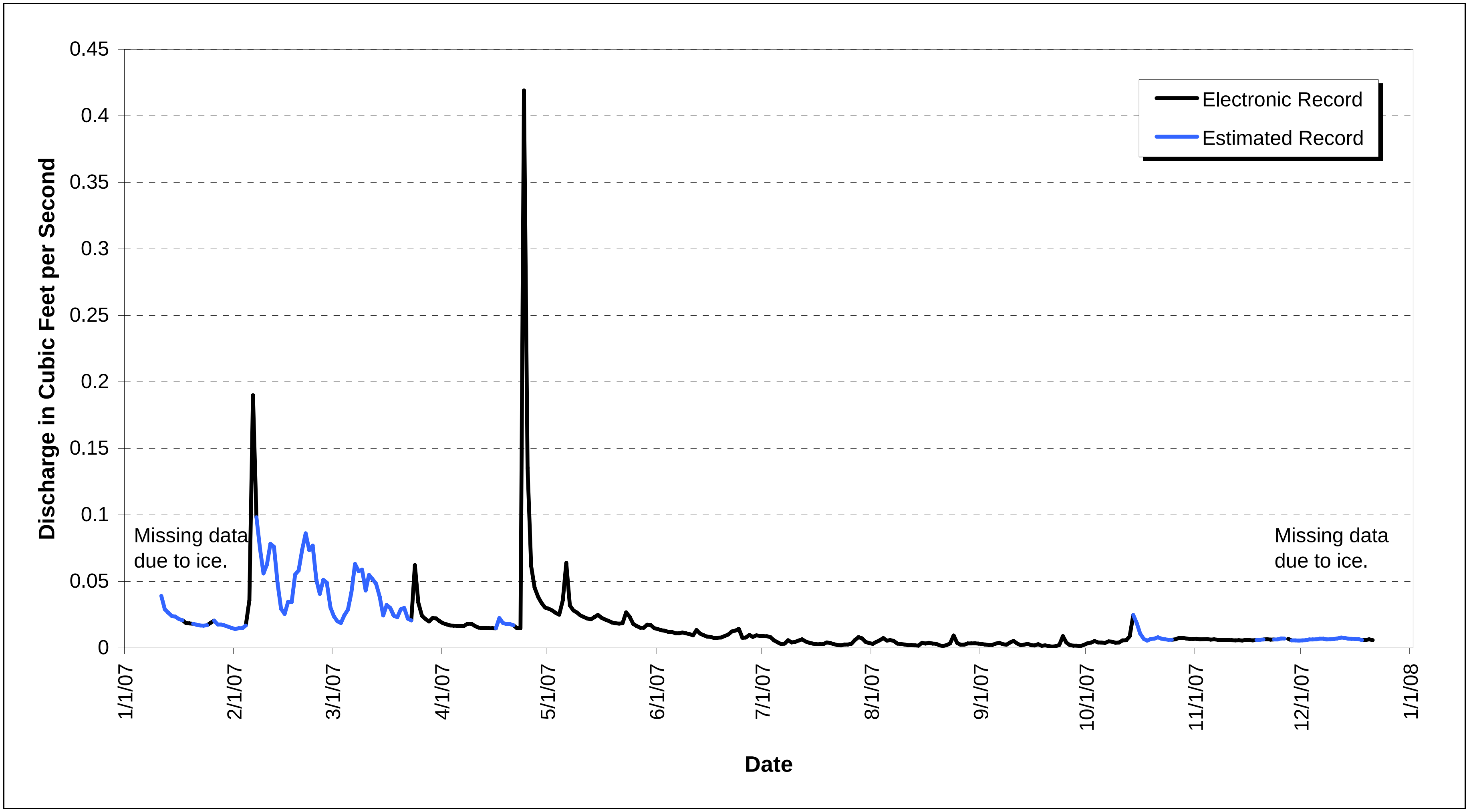



*Figure 3-92. CY 2007 Mean Daily Hydrograph at SW018: FC-2 at FC-2 Wetland*

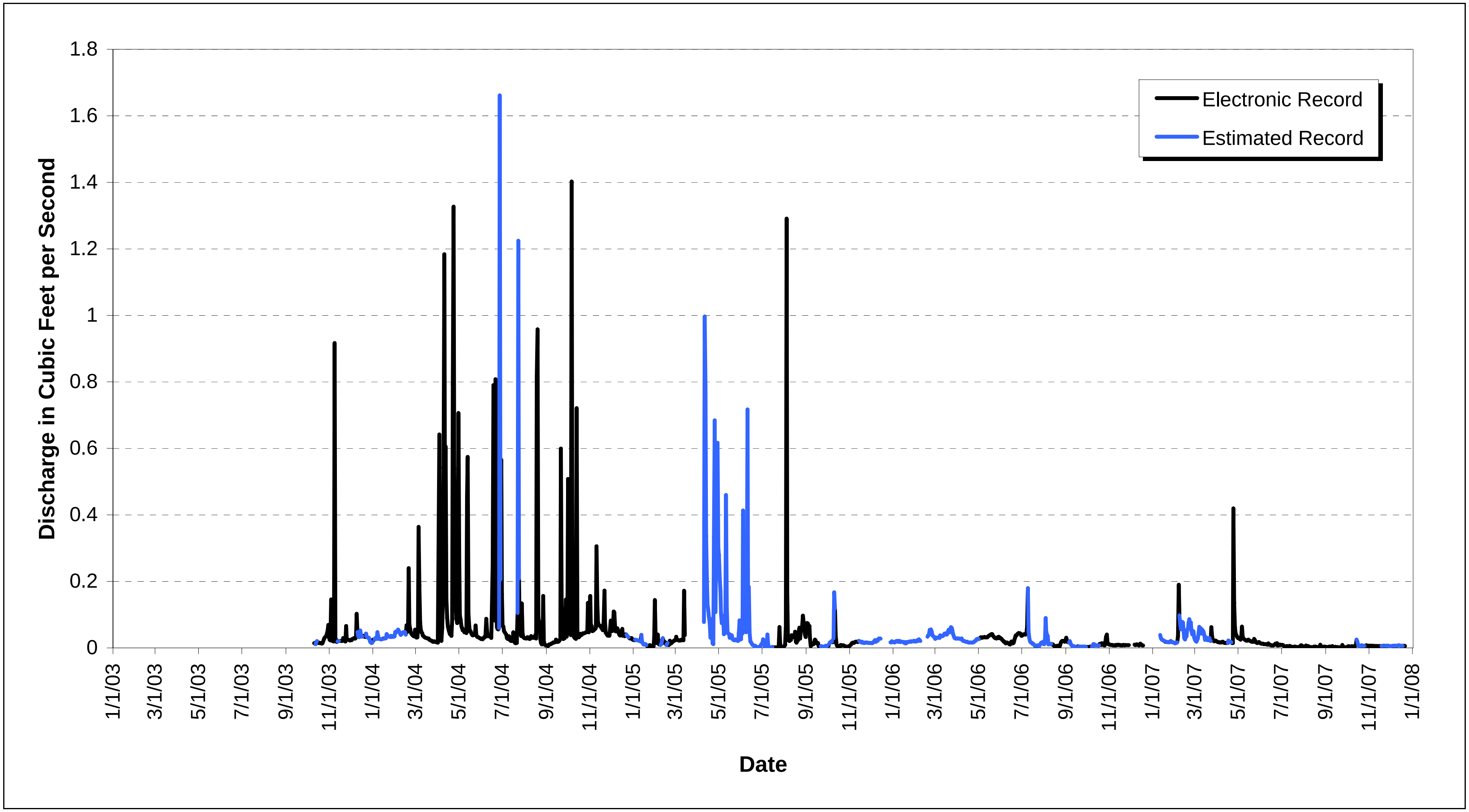



*Figure 3-93. CY 2003−2007 Mean Daily Hydrograph at SW018: FC-2 at FC-2 Wetland*

### *SW027: SID at Pond C-2*

***Location***—East end of SID at Pond C-2; State Plane: E2088527, N748044.

***Drainage Area***—The basin includes a portion of the southern COU drained by the SID (total of 177.6 acres).

***Period of Record***—September 11, 1991, to current year.

***Gage***—Water-stage recorder and dual, parallel 120° V-notch weirs.

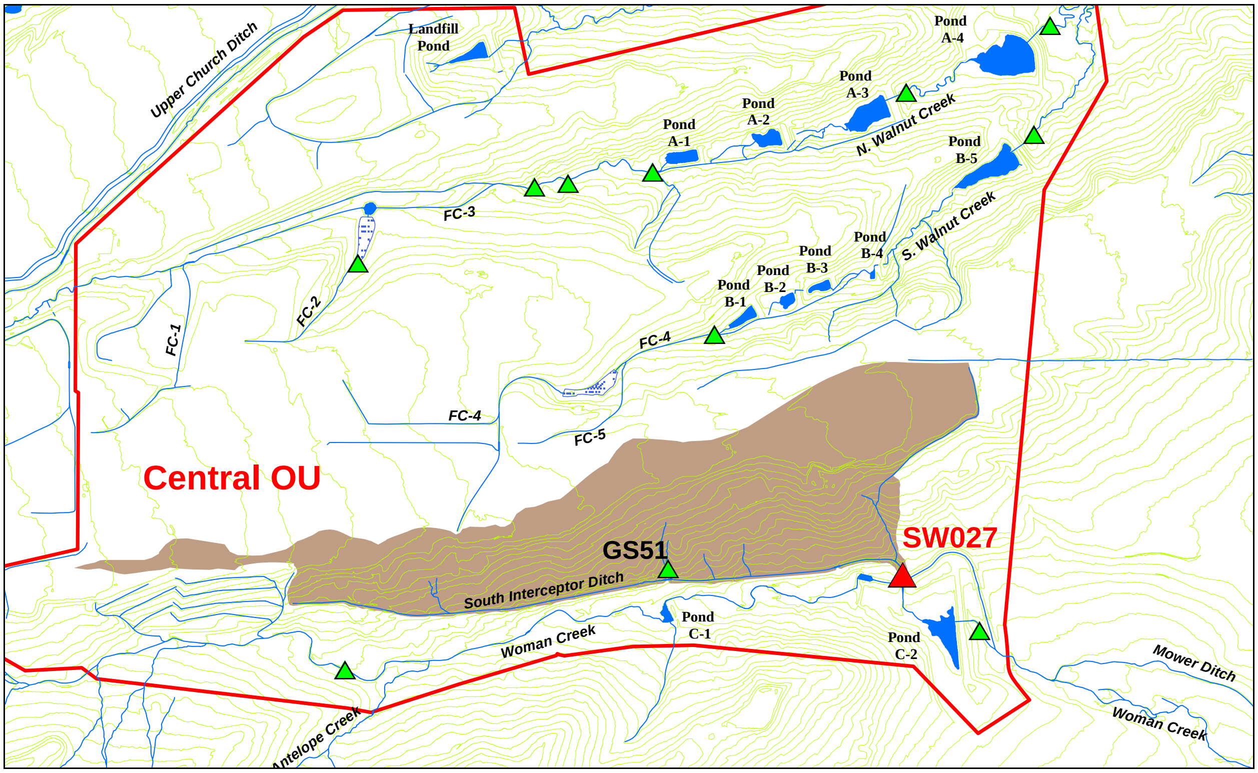



*Figure 3-94. SW027 Drainage Area*

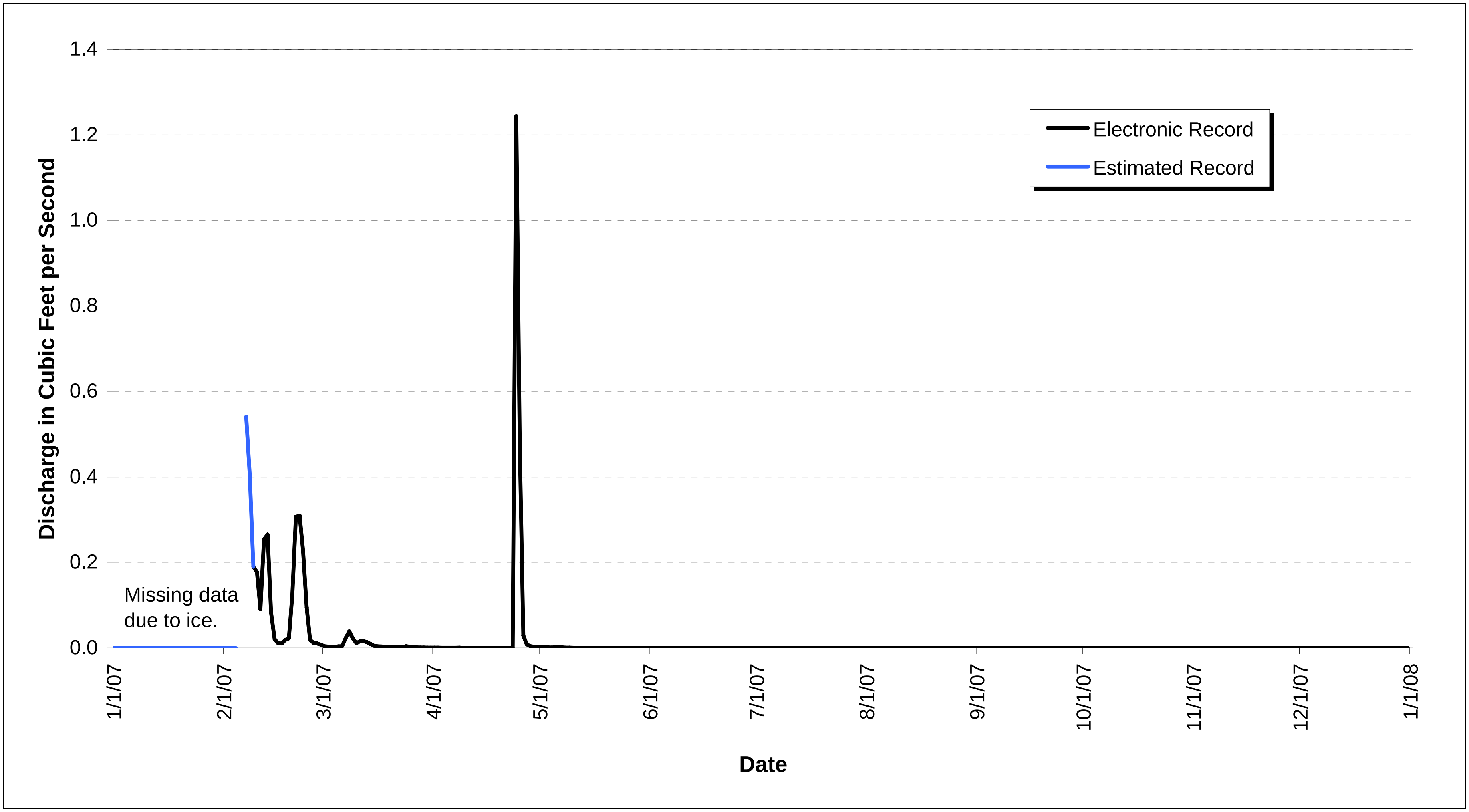



*Figure 3-95. CY 2007 Mean Daily Hydrograph at SW027: SID at Pond C-2*

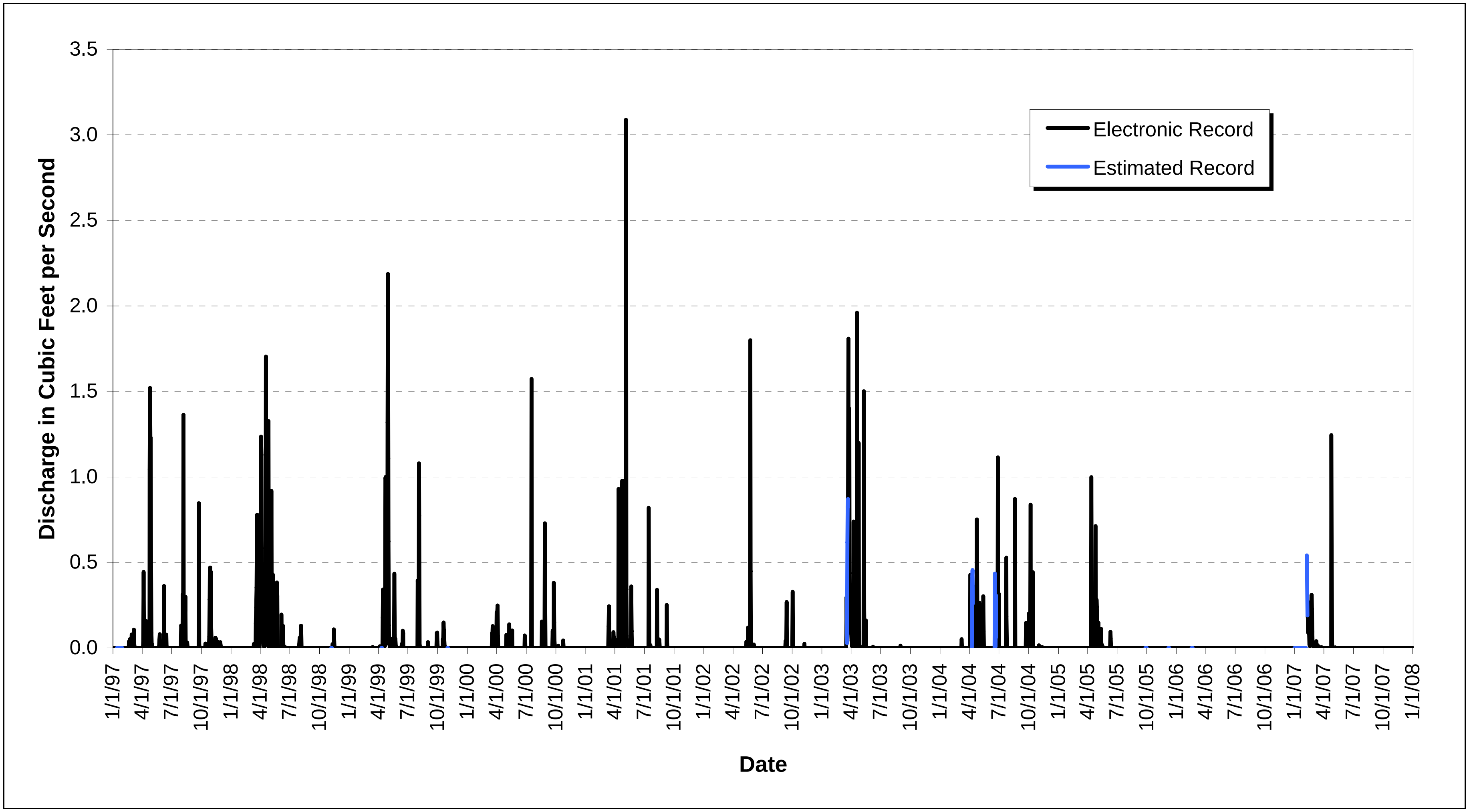



*Figure 3-96. CY 1997−2007 Mean Daily Hydrograph at SW027: SID at Pond C-2*

### *SW093: North Walnut Creek Upstream of Pond A-1 Bypass*

***Location***—North Walnut Creek 1,300 feet above Pond A-1 Bypass; State Plane: E2085030, N751730.

***Drainage Area***—The basin includes the northwestern portion of the COU drained by FC-3 (total of 220.0 acres).

***Period of Record***—September 11, 1991, to current year.

***Gage***—Water-stage recorder and 36-inch suppressed, rectangular, sharp-crested weir to January 27, 2003; rated stream section during new flume construction (SW093T; January 27, 2003−May 29, 2003). Three-foot H flume starting May 29, 2003.

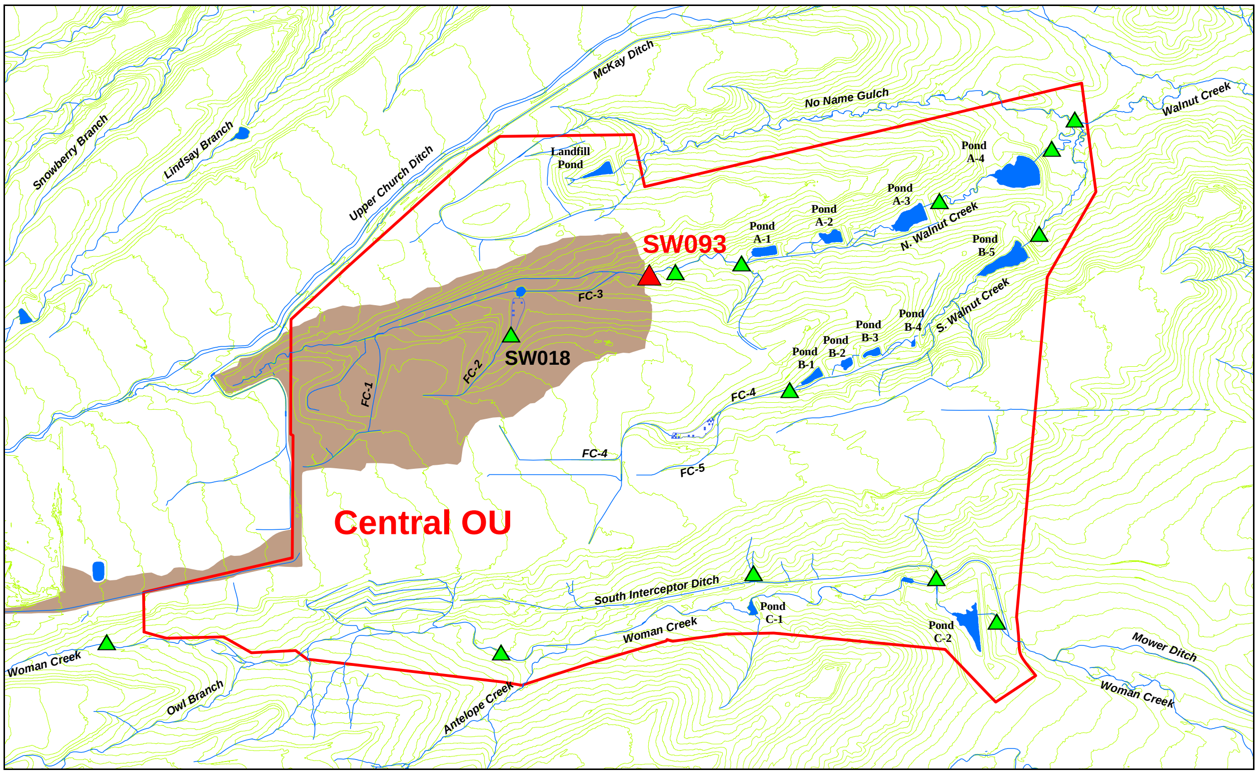



*Figure 3-97. SW093 Drainage Area*

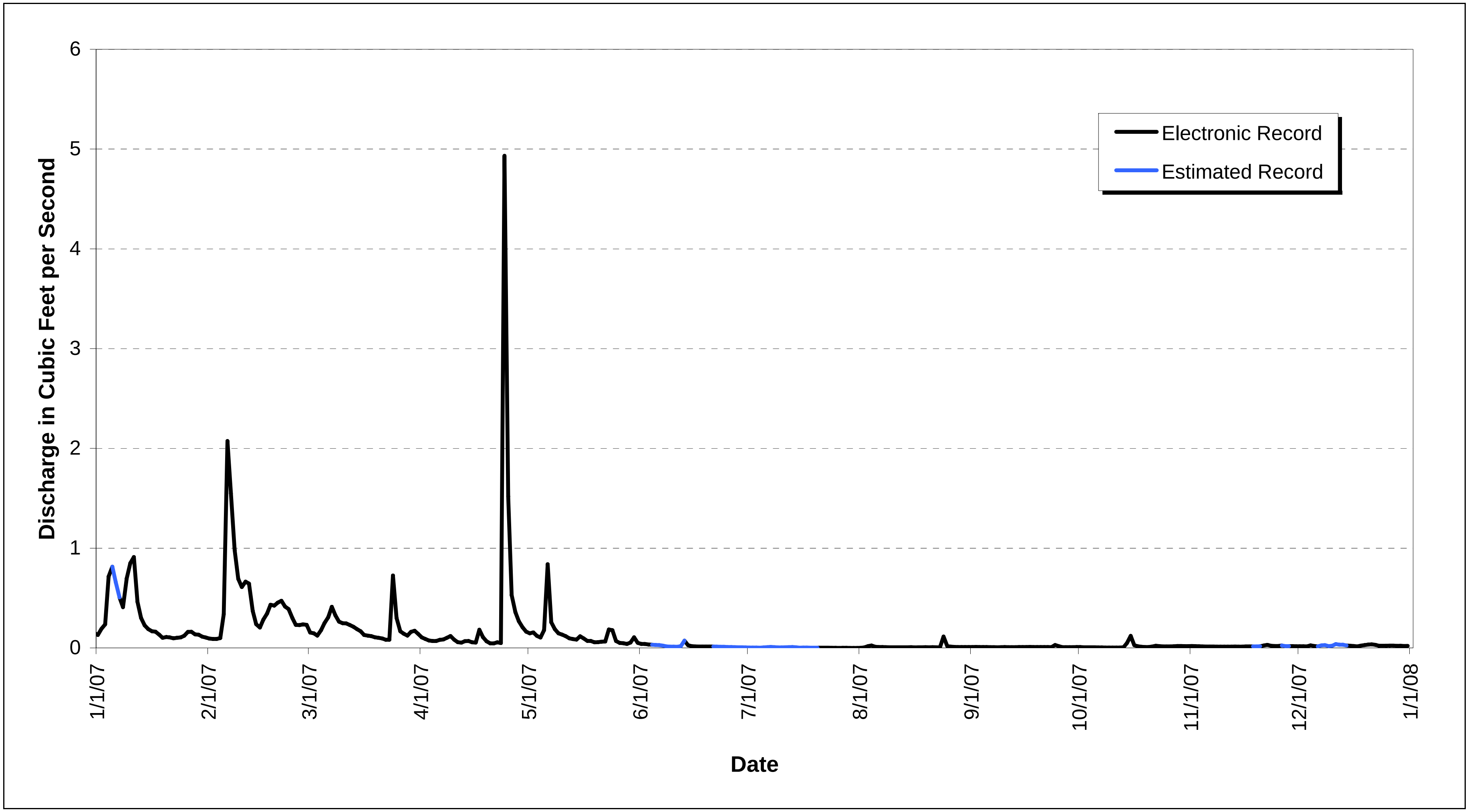



*Figure 3-98. CY 2007 Mean Daily Hydrograph at SW093: North Walnut Creek Upstream of Pond A-1 Bypass*

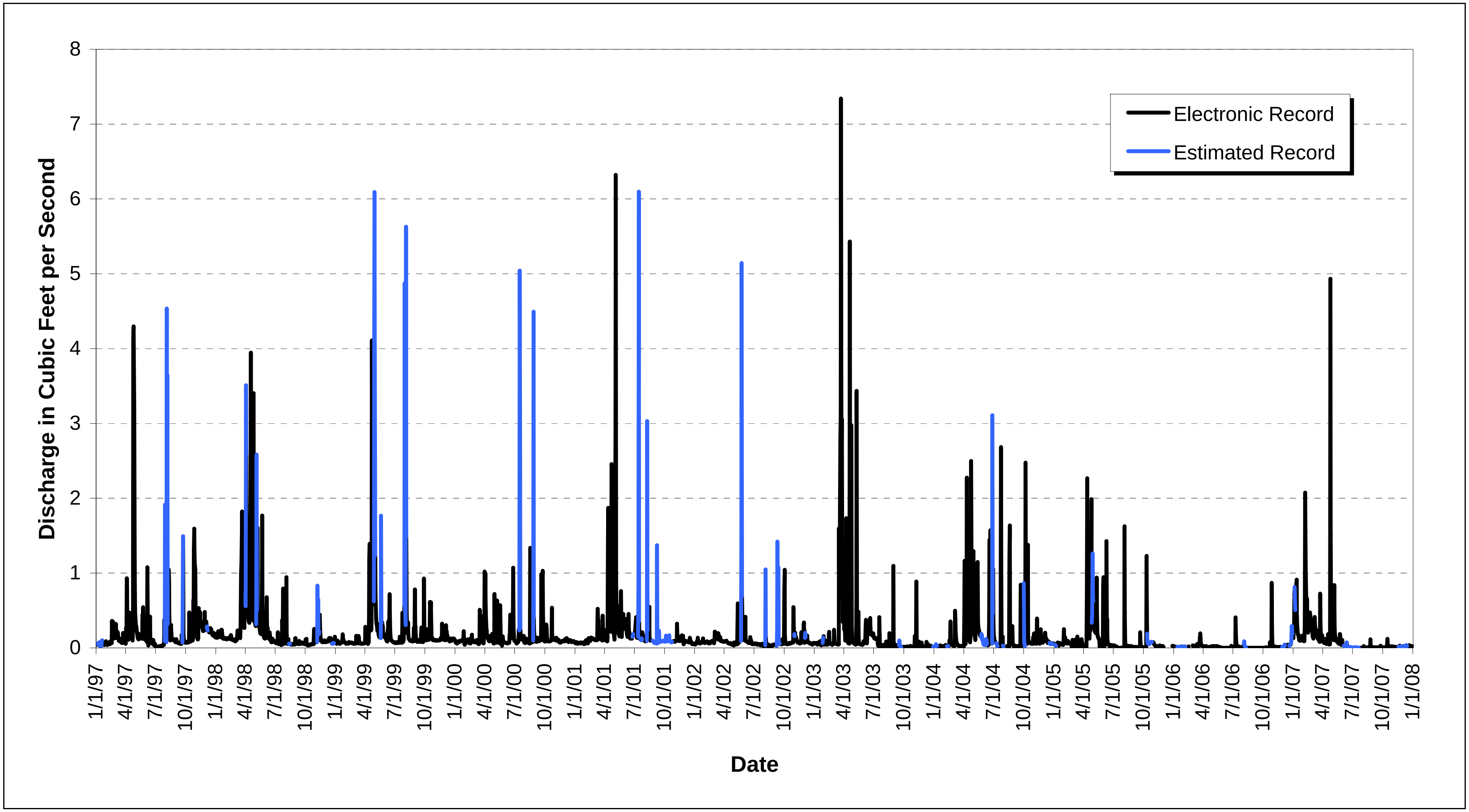



*Figure 3-99. CY 1997−2007 Mean Daily Hydrograph at SW093: North Walnut Creek Upstream of Pond A-1 Bypass*

### 3.1.3.4 Precipitation Data

During CY 2007, 10 precipitation gages were operated as part of the automated surface-water monitoring network (Table 3-39 and Figure 3-100). The locations employ tipping-bucket rain gages generally mounted at ground level. Precipitation totals are logged on 5- and/or 15-minute intervals. The gages are not heated and will not accurately record equivalent precipitation for all snowfall events. The following sections present several figures (Figure 3-101, Figure 3-102, Figure 3-103, Figure 3-104, Figure 3-105, and Figure 3-106) summarizing the precipitation data collected for CY 1997−2007.

*Table 3-39. Monitoring Network Precipitation Gage Information*

| Location Code (Surface-Water Gage) | Easting (State Plane) | Northing (State Plane) | Period of Operation |
|---|---|---|---|
| PG55 [NA] | 2087857.63 | 747141.16 | 7/19/94−8/23/07 |
| PG56 [NA] | 2091790.63 | 752716.35 | 7/18/94−3/22/07 |
| PG58 [GS01] | 2093835.22 | 744921.16 | 10/11/96−current year |
| PG59 [GS03] | 2093598.99 | 753629.51 | 4/1/96−current year |
| PG61 [GS05] | 2078432.10 | 747285.45 | 4/1/96−current year |
| PG72 [NA] | 2083387.82 | 751851.00 | 6/7/05−current year |
| PG73 [GS13] | 2086169.70 | 751862.47 | 9/27/05−current year |
| PG74 [GS59] | 2083245.00 | 747172.00 | 9/5/06−current year |
| PG76 [NA] | 2091963.00 | 752705.00 | 3/28/07−current year |
| PG77 [NA] | 2087329.00 | 746937.00 | 8/23/07−current year |

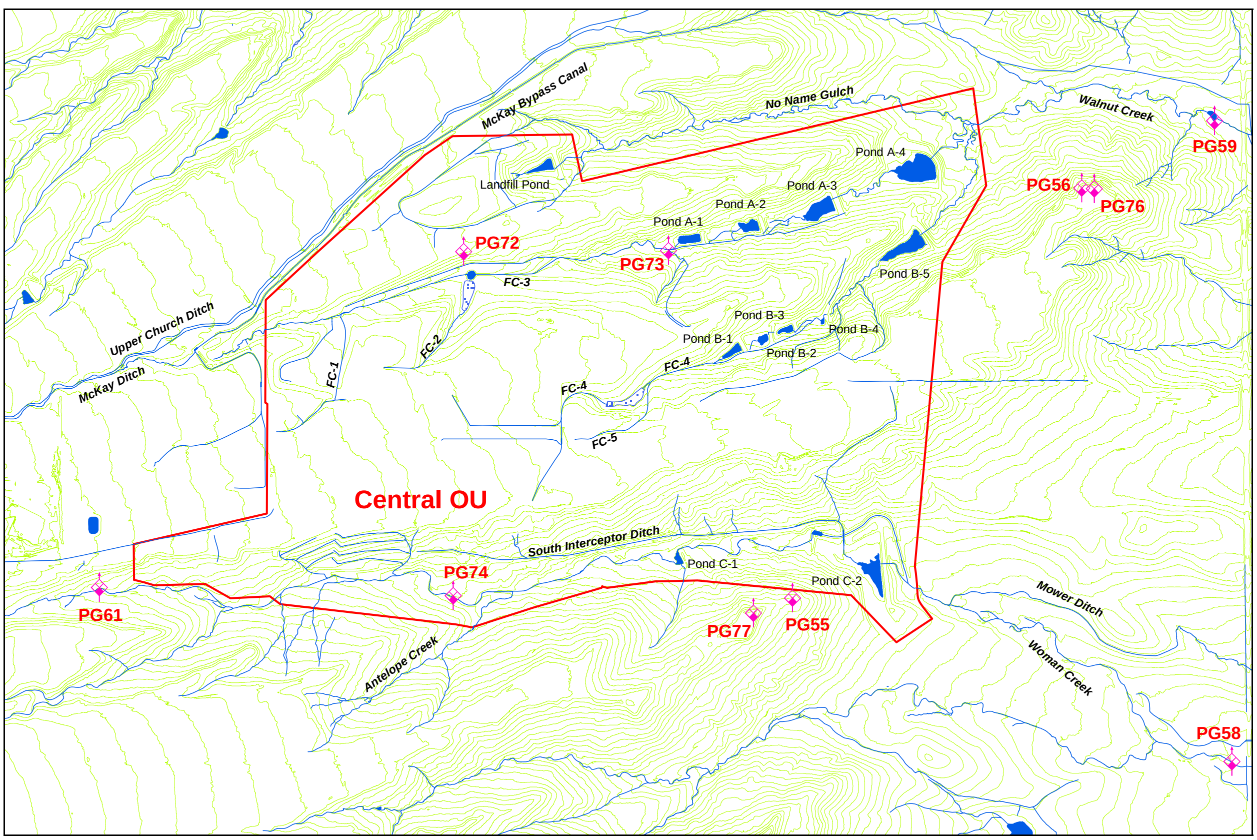
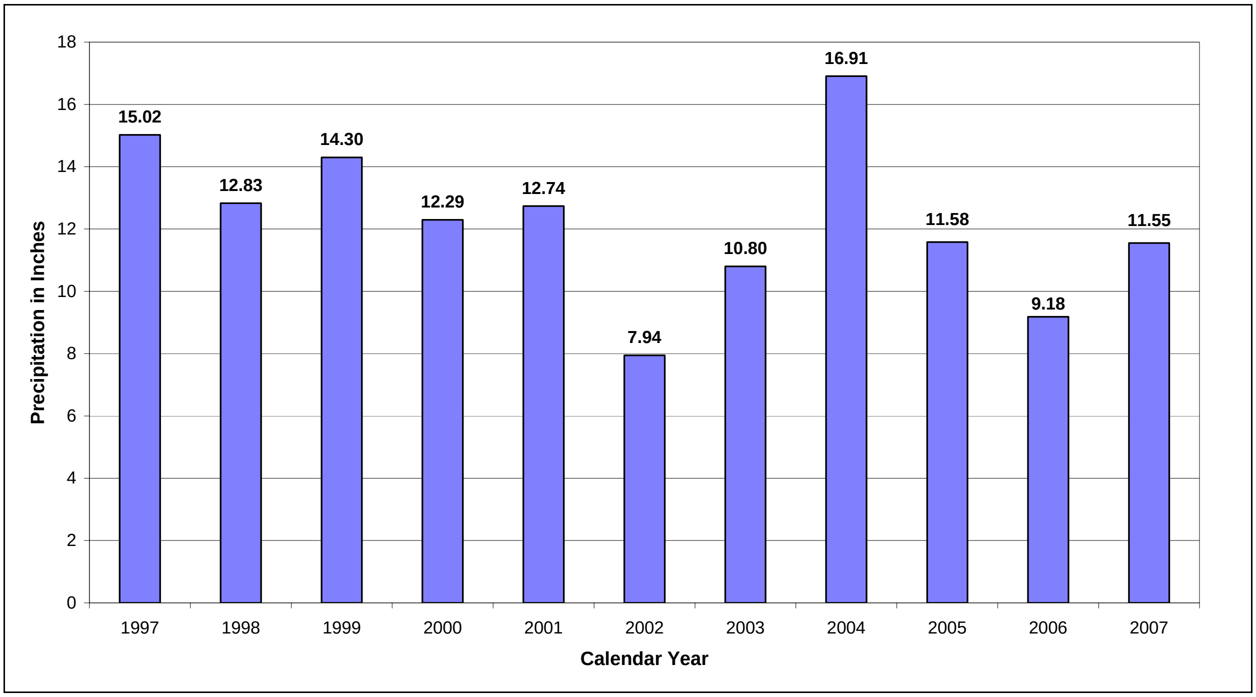


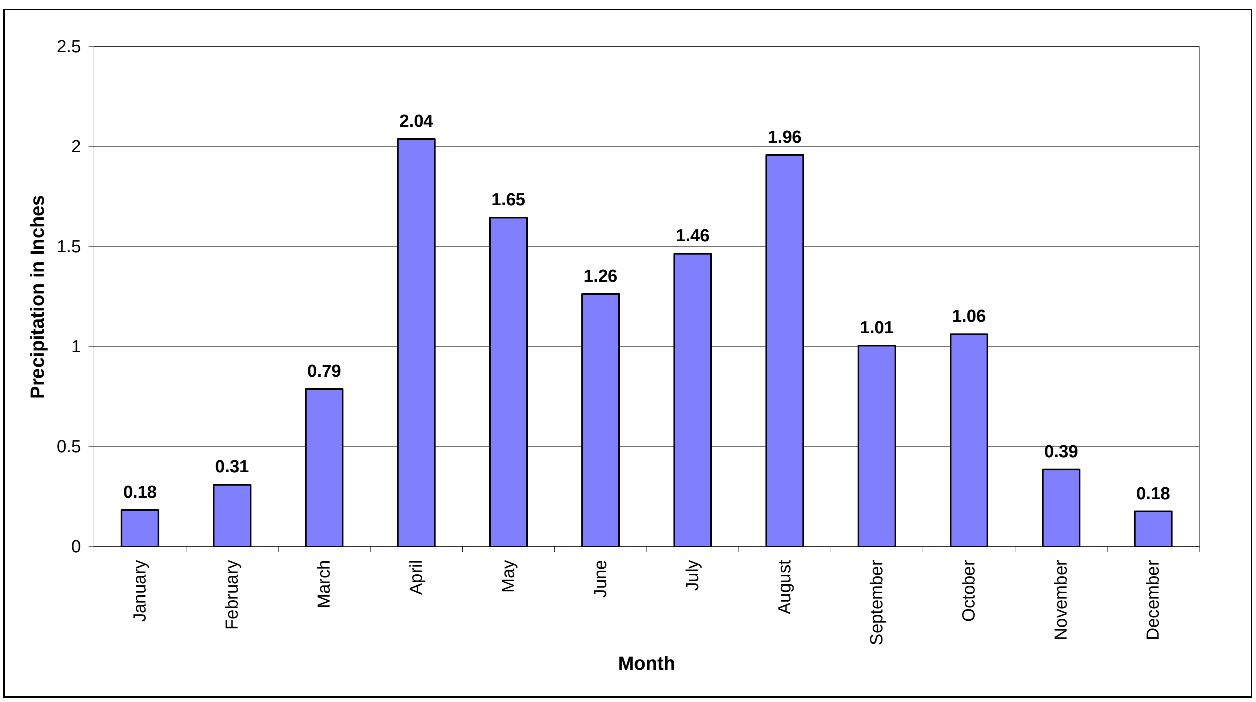

*Figure 3-100. Site Precipitation Gages: CY 2007*

## *CY 1997–2007 Summary*



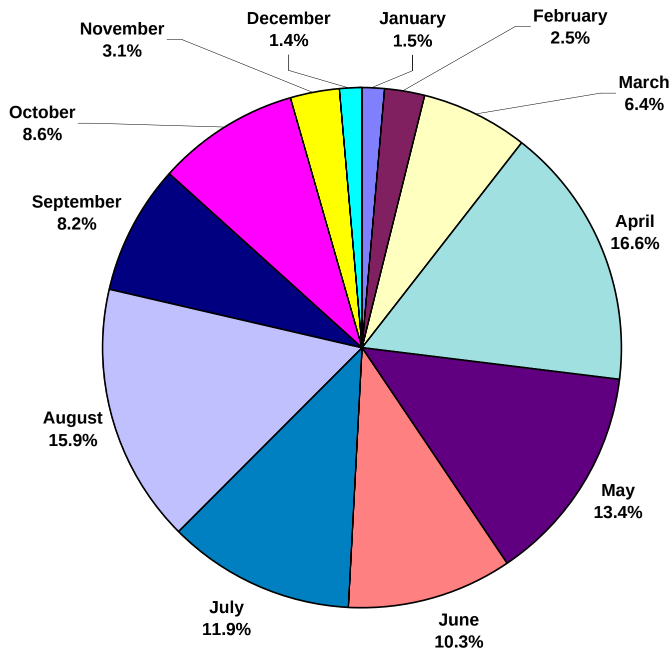

Note: Arithmetic average of gages in operation.

*Figure 3-101. Annual Total Precipitation for CY 1997–2007*




Note: Arithmetic average of gages in operation.

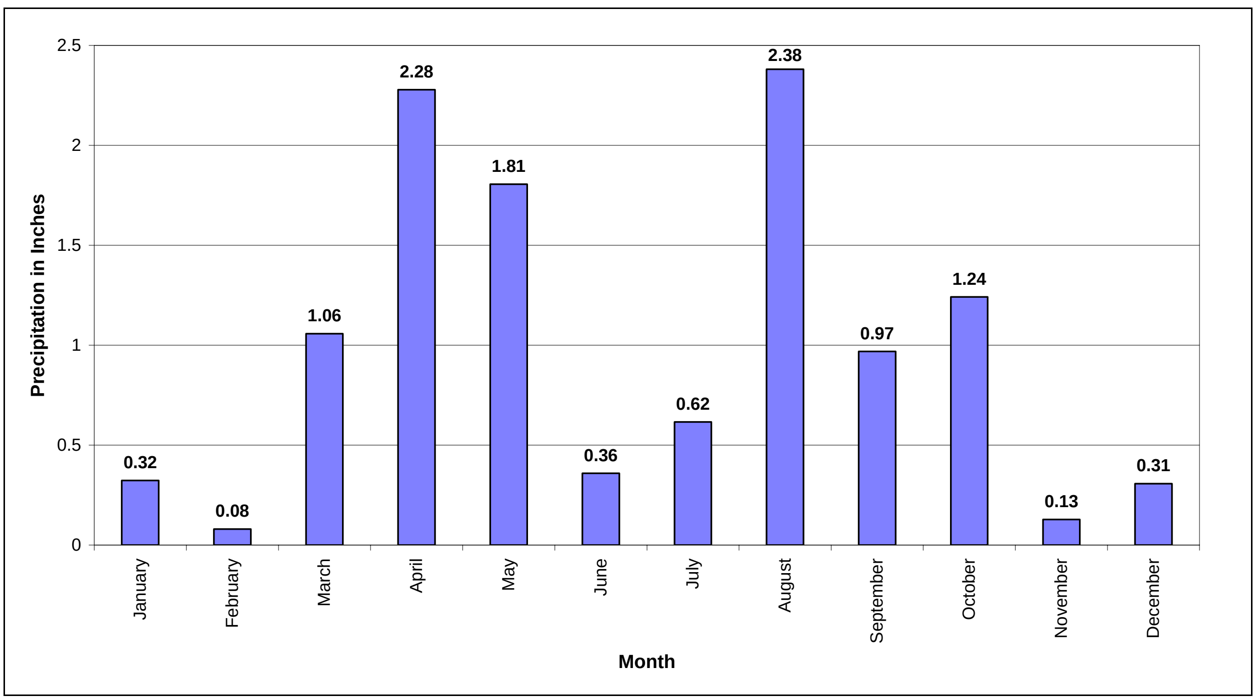
*Figure 3-102. Average Monthly Precipitation for CY 1997–2007*




Note: Arithmetic average of gages in operation.

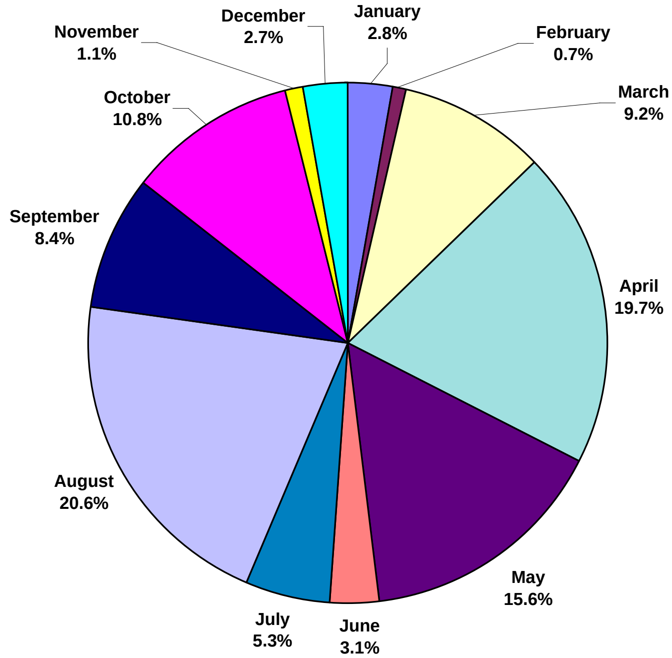
*Figure 3-103. Relative Monthly Precipitation Totals for CY 1997–2007*

## *CY 2007 Summary*



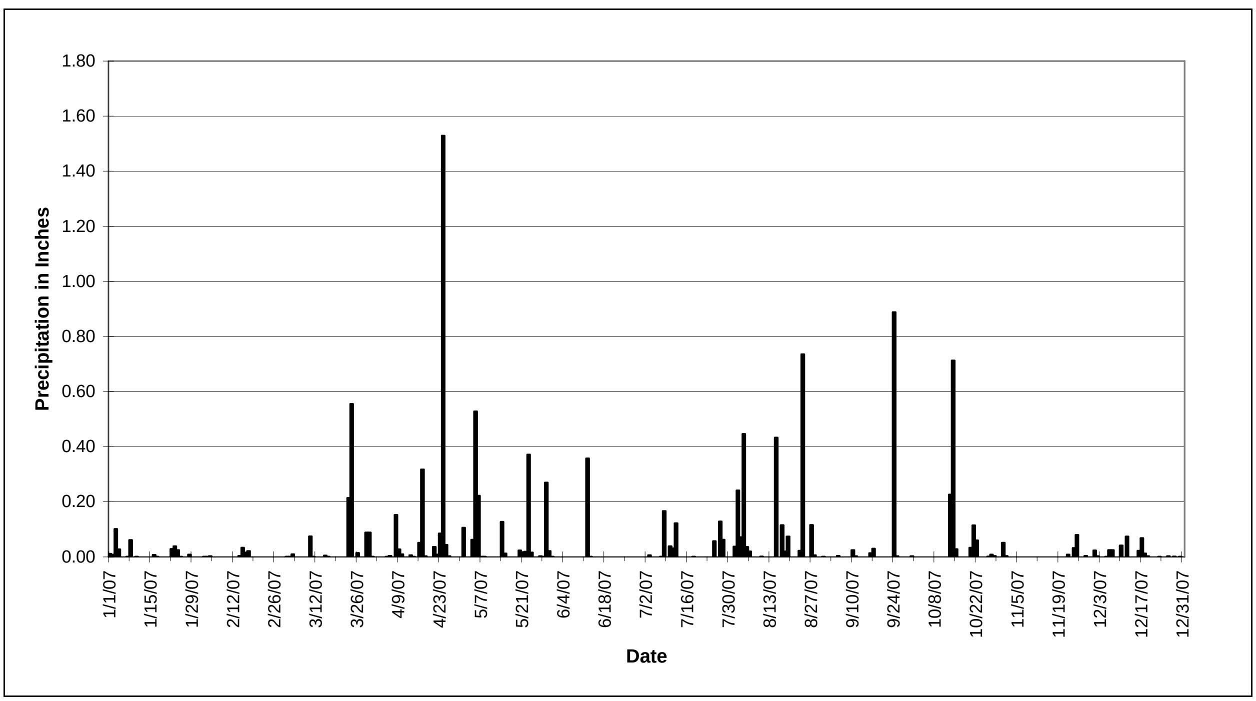

Note: Arithmetic average of gages in operation.

*Figure 3-104. Monthly Precipitation for CY 2007*




Note: Arithmetic average of gages in operation.

*Figure 3-105. Relative Monthly Precipitation Volumes for CY 2007*




Note: Arithmetic average of gages in operation.

*Figure 3-106. Daily Precipitation Totals for CY 2007*

### 3.1.3.5 Groundwater Flow

This section summarizes groundwater elevations and flow characteristics. Groundwater elevation data are discussed through the construction and interpretation of potentiometric surface maps and hydrographs. Groundwater flow characteristics are then assessed, including flow velocities.

***Groundwater Elevations***

Groundwater elevation data were collected at the start of the second and fourth quarters in 2007; these data are included in Appendix A. These data were plotted and hand-contoured to create potentiometric surface maps. The potentiometric surface map for second quarter CY 2007 is included as Figure 3-107, and the map for fourth quarter CY 2007 is included as Figure 3-108. These maps are derived from manual water level measurements.

Monitoring wells at Rocky Flats are screened within the UHSU. The UHSU encompasses unconsolidated surface materials such as Rocky Flats Alluvium, hillslope colluvium, valley-fill alluvium, and artificial fill (all of which are often referred to as “alluvium”), and underlying weathered bedrock (most often the Cretaceous-aged Laramie Formation or the Cretaceous-aged Arapahoe Formation). A well screened entirely within the weathered bedrock may yield different water levels than an adjacent well screened in the alluvium.

Seeps posted on both potentiometric surface maps are from the 1995 Hydrogeologic Characterization Report (EG&G 1995a). This depiction of seeps is the best available map of the seeps for the Site. However, it is no longer accurate, having been most strongly affected by the removal of all artificial water sources, as well as land surface reconfiguration (e.g., excavations and placement of fill) in some areas. Potentiometric surface maps for 2007 are based on many fewer locations than pre-closure years, and are therefore less detailed in comparison. The areas of interest in post-closure years are the former IA and adjacent areas.

There are several locations on the potentiometric maps labeled as dry. Wells are labeled dry if they are measured to be dry, or if the water level measured is below the bottom of the screened interval (water below the screen is stagnant and may not reflect the actual water level). The locations labeled as dry may indicate areas that are unsaturated. These areas are a result of limited groundwater, caused by a reduction in recharge from precipitation (e.g., droughts, such as that in 2002) or the reduction in contributions from artificial sources (e.g., removal of water lines, foundation drains, and dust suppression water). However, many wells in the monitoring network do not fully penetrate the UHSU; therefore, locations depicted as dry may not truly be unsaturated, but rather may be saturated at depths greater than that of the associated well.

Unsaturated areas in 2007 are similar to those depicted in 2006. Unsaturated areas in the second and fourth quarters include parts of the OU 1 Plume and each of the three groundwater treatment systems. (Refer to Section 3.1.5.3 for a discussion of the several historically named plumes at Rocky Flats). These four areas are typically dry due to the dewatering effects of the associated groundwater intercept trenches or, at the OU 1 Plume, the nearby defunct French drain. Groundwater flow paths in 2007 are consistent with 2006, as estimated from the potentiometric surface maps (Figure 3-107 and Figure 3-108).

Water levels in 2007 appear to be equilibrating from closure activities, as shown in the area surrounding former B371 (Figure 3-107 and Figure 3-108). This area no longer appears to act as a groundwater sink since the disruption of the foundation drains. A similar pattern is suggested by the groundwater distribution in the areas of former B771 and B883/B881, which were also strongly influenced prior to closure by foundation drains but appear to be equilibrating in 2007.

Water levels are generally higher in the second quarter than the fourth quarter because of seasonal influences (recharge from spring precipitation, followed by drier conditions and continuing discharge via baseflow and evapotranspiration). Prior to closure, other influences—most particularly, the addition of imported water to the hydrologic system—were also major factors in some areas but this is no longer the case.

Precipitation in 2007 was recorded at eight locations across the Site. The “total” precipitation (i.e., as measured by unheated rain gauges, which do not accurately reflect precipitation totals related to snowfall) recorded at the Site in CY 2007 was 11.55 inches. This is consistent with the historical average for annual precipitation totals (11.91 inches). Table 3-40 summarizes precipitation totals for recent CYs, and displays the total precipitation for 2007. Note that the amount shown for 2003 incorporates March data from the Site’s former 61-meter meteorology tower, which included a heated precipitation gauge that recorded precipitation from the multi-foot March 2003 snowstorm more accurately than did the unheated gauges operated by the Water Programs Group. See Section 3.1.3.4 for additional discussion of precipitation.

*Table 3-40. Calendar Year Precipitation Totals at the Site*

| Calendar Year | Total Precipitation (inches) |
|---|---|
| 1993 | 12.27* |
| 1994 | 10.64 |
| 1995 | 16.49* |
| 1996 | 12.36 |
| 1997 | 15.02* |
| 1998 | 12.83* |
| 1999 | 14.30 |
| 2000 | 12.29 |
| 2001 | 12.74* |
| 2002 | 7.94 |
| 2003 | 12.35 |
| 2004 | 16.91 |
| 2005 | 11.58 |
| 2006 | 9.18 |
| 2007 | 11.55 |

Notes: Total precipitation listed is an average of all precipitation gauges operating that year at the Site. In 2007, this was eight gauges. *Value corrected from that included in 2005 Annual Report. Correction factors were 0.01 to 0.03 inches.

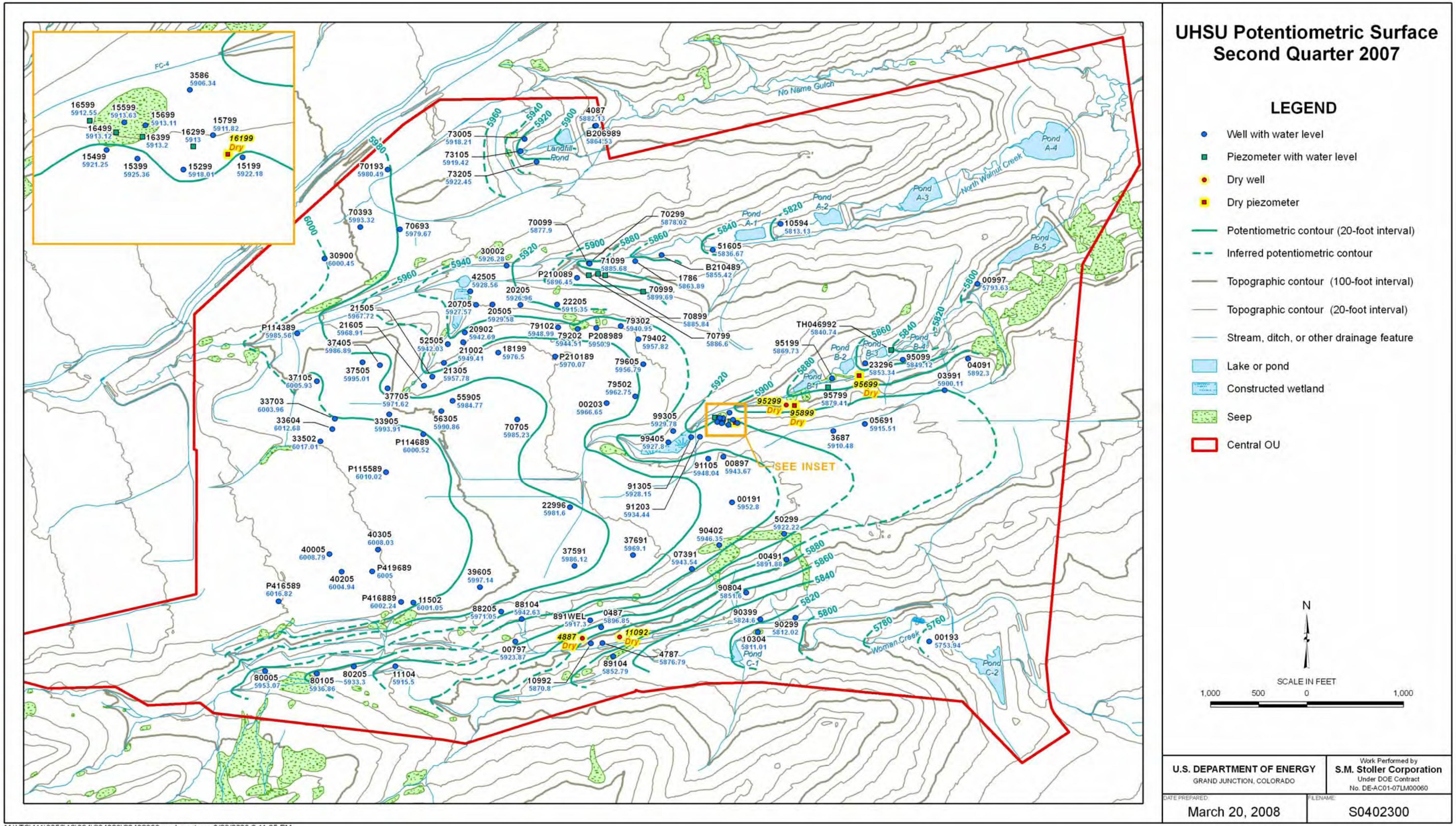
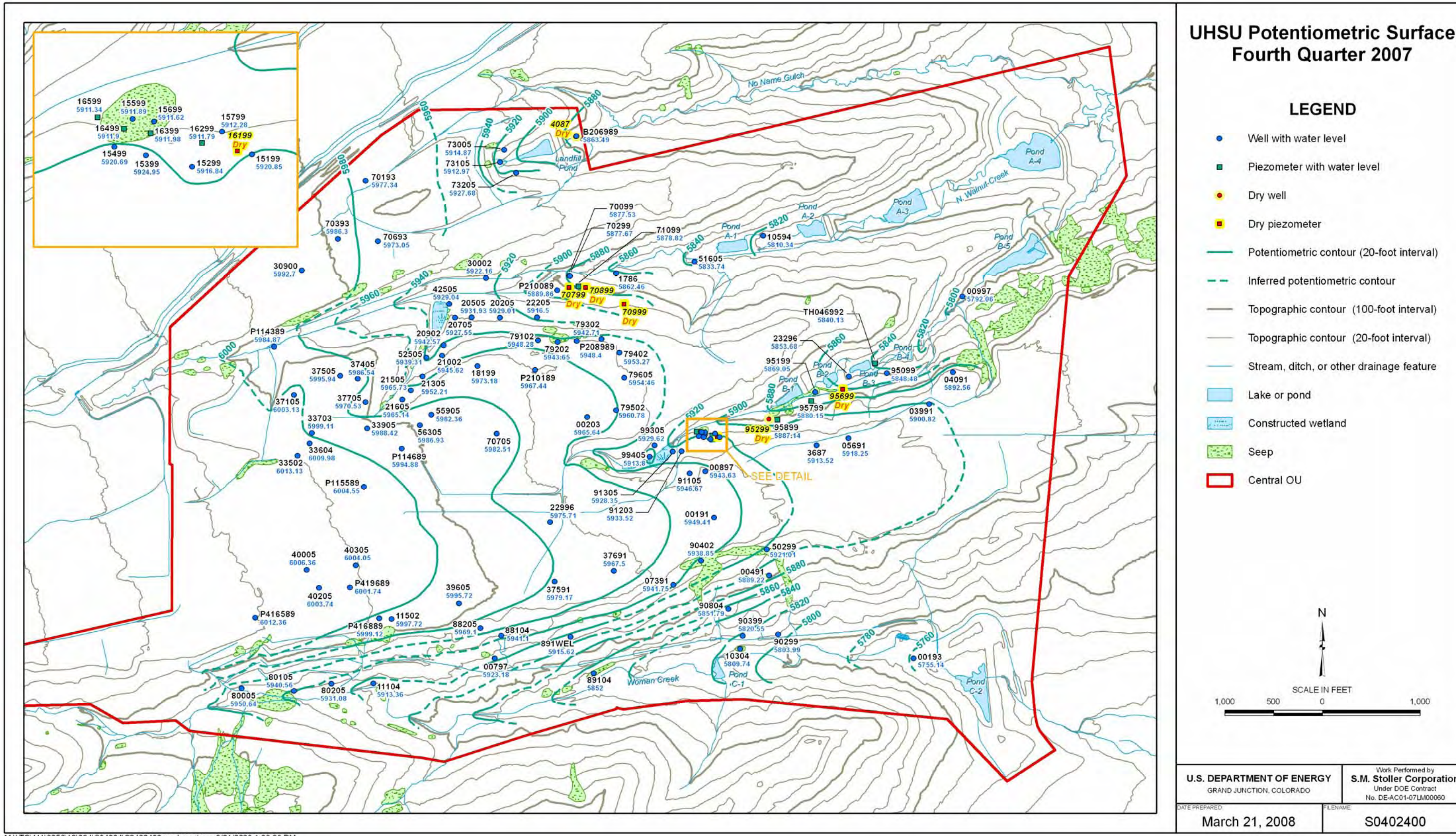



*Figure 3-107. UHSU Potentiometric Contours: Second Quarter CY 2007*



M:\LTS\111\0056\12\004\S04024\S0402400.mxd coatesc 3/21/2008 1:38:38 PM

*Figure 3-108. UHSU Potentiometric Contours: Fourth Quarter CY 2007*

### *Hydrographs*

Water level measurements provide additional information on the hydrogeologic conditions surrounding the wells, as well as well recharge patterns. Hydrographs were prepared and are included in Appendix A.4. Selected groups of hydrographs are discussed here. It may be helpful to refer to the referenced hydrographs throughout the following discussion; otherwise, much of the text will have little meaning.

As in the previous two annual reports (DOE 2006e, 2007e) and similar to the treatment of analytical data as discussed above, water level data for original and replacement wells are combined into a single hydrograph under the assumption that the corresponding data are continuous. (As additional data are collected this assumption may prove to be false at some locations, in which case the corresponding data will no longer be pooled.) Water level data used for these hydrographs includes routine, pre-sampling, and special-request measurements.

Water level elevations were calculated by subtracting the measured depth to water from the surveyed elevation of the top of the well casing. When wells were found to be dry, the water level posted on the hydrograph is equivalent to the elevation of the bottom of the well casing, as calculated from the total depth of well casing recorded during its installation. The same water level is posted when the measured water level is found to be below the bottom of the screened interval, because this water is not in hydraulic connection with saturated materials and is therefore likely not representative.

Note that water levels for first quarter CY 2007 were not measured due to inclement weather; multiple blizzards and heavy snowfall rendered the Site essentially inaccessible. In addition, the hydrograph for well 45605 was not constructed. This well was installed within the slump south of former B991 that developed beginning in January 2006 (see DOE 2006e and 2007e for more information). Because of the resulting continual changes in ground surface elevation at that well, water level elevations based on measurements referencing the original ground and top of casing elevations are not accurate. This well was abandoned following fourth-quarter sampling in October 2007; a replacement well will be installed in 2008. See Section 2.7.2 for additional discussion of the slump.

Wells are grouped and discussed by geographic proximity, hydrogeologic setting, and contamination plume. Typically, the resulting groups of wells are represented by hydrographs with similar patterns. Many hydrographs display a rebound in 2007 following the dry conditions of 2006. This rebound has a strong seasonal signature, with the highest water levels in spring followed by a decline through the end of 2007. Water levels in 2007 appear to have stabilized, and may no longer be influenced by closure activities.

The contaminant plumes in the eastern portion of the former IA, including the Oil Burn Pit (OBP) #2 Plume, Mound Site Plume, 903 Pad/Ryan's Pit Plume, and East Trenches Plume, are discussed together based on their geographic proximity and commingled contaminants. Groundwater from both the OBP #2 Plume and the Mound Site Plume is captured by the MSPTS. Well 91105, located in the OBP #2 source area, is represented by a relatively uniform hydrograph, although some rebound is evident in 2007. The hydrograph for well 91203, located a short distance north of well 91105, shows a very similar pattern in 2006 and 2007 following increasing water levels in spring 2005. Increasing water levels in 2005 are discussed in the 2005

Annual Report (DOE 2006e), and may be attributed to the re-routing of 700 Area water through an unlined ditch upgradient of this well (and downgradient of well 91105). Farther downgradient and on the southern margin of the FC-4 constructed wetland, well 91305 also shows a similar pattern, although the magnitudes of these water level changes are smaller than in the wells upgradient. The hydrograph for Mound source-area well 00897, which is located closest to OBP #2 well 91105, does not show a strong resemblance to the aforementioned hydrographs, although a seasonal increase in water levels in spring 2007 is evident.

Wells in the area of the MSPTS include 15199, 15299, 15399, 15499, 15599, 15699, 15799, and 3586. (91203 can also be considered within the area, but has been discussed above.) The three wells on the upgradient side of the MSPTS groundwater intercept trench, 15299, 15399, and 15499, all show a very similar hydrograph. This pattern is marked by a seasonal drop in water levels (to dry conditions in well 15299) in the second half of 2006, followed by a rebound in 2007. In the hydrograph for well 15499, located at the western end of the trench, this rebound is very subtle; water levels have been steadily rising since 2003 with minimal decrease in water level in response to the dry year of 2006. This is almost certainly due to the influence (as of mid-2005) of water within the diverted storm drain corridor from OBP #2, which is now directed to the MSPTS intercept trench as discussed above and in previous reports (e.g., DOE 2007e). Conversely, hydrographs for wells on the downgradient side of the intercept trench—15599, 15699, 15799, and 3586—differ from this pattern and from each other. Of greatest interest is the hydrograph for Sentinel well 15699, which is marked by a strong seasonal pattern since 2005, with each year’s maximum water level above that of the prior year. (This hydrograph shows a drop in water levels that reflects sampling in May 2007.) In addition, the pattern for well 15799, which is typically dry, includes measurable water levels throughout 2007, with a strong seasonal (spring recharge) component. On the east, beyond the eastern end of the MSPTS groundwater intercept trench, well 15199 is represented by a hydrograph that is similar to those for the upgradient trench wells (particularly wells 15299 and 15399) but with higher-magnitude fluctuations. In summary, wells on the upgradient side and eastern end of the intercept trench show seasonal recharge that is affected by the groundwater contributions of the OBP #2 storm drain corridor. The magnitude of those effects is proportional to the proximity to the western end of the intercept trench; with increasing distance from the point at which that corridor ties to the MSPTS intercept trench (i.e., comparing wells 15299 and 15499), the effect of this added water is less noticeable on the hydrographs. However, as this water is probably the mechanism responsible for the higher water level elevations in most wells in the area of the MSPTS since 2005, it is probably also responsible for the presence of measurable groundwater in well 15299 in the same time period.

Wells 07391, 00191, and 90402 are located near Ryan’s Pit and the 903 Pad. Hydrographs for these wells show a similar pattern of rebound between the last reading in 2006 and the first in 2007, although the magnitude of rebound at 90402 (approaching 10 feet) is much greater than at either 07391 (close to 4 feet) or 00191 (approximately 5 feet). Wells 50299, 00491, 90804, 90399, and 90299 monitor the downgradient portion of the plume, and—except for 90804—also show similar rebounds in 2007. Well 90804 monitors a detachment plane beneath a slump, and to date shows little variation in water level regardless of climatic influences. In summary, effects of closure on groundwater levels in the 903 Pad/Ryan’s Pit Plume area are minimal, and except for well 90804 the hydrographs for these wells show a fairly strong rebound in water levels in 2007.

The East Trenches Plume is monitored by wells 3687, 05691, 03991, and 04091. The hydrographs for these wells are generally similar in 2006 and 2007. Hydrographs for wells nearer the former IA—3687 and 05691—show a somewhat higher amplitude rebound in 2007 than do the more distal wells, 03991 and 04091, although this last well goes dry and therefore its hydrograph does not depict the full range of water levels at that location. Notably, this well—04091—did not go dry in 2007, in contrast to the entire year of 2006. Interestingly, the hydrograph for well 05691 indicates higher than average water levels are typically observed during odd-numbered years, but this is almost certainly a coincidence.

Wells monitoring groundwater around former B771/774 include 18199, 20902, 21002, 20205, 20505, and 20705. The hydrographs for these wells all show similar patterns: a water level decrease in the relatively dry year of 2006 followed by a rebound in spring 2007. Some wells, most notably 18199 and 20505, show a lowered water level during 2004-2005 that may relate to groundwater equilibrating within the subsurface at former B771/774. As this area had been kept artificially dry by the building's foundation drain system, much of the building footprint would have represented a groundwater "sink" that was then slowly filled after the drain was disrupted. Water elevations now appear to be stabilizing at close to the same values as was the case prior to closure. In summary, wells in this area were affected by closure activities in 2006, but are stabilizing and display more seasonal influences in 2007.

Wells monitoring the former B371/374 complex include 37105, 37405, 37505, 37705, and the more distant P114389. Wells in the area immediately adjacent to the buildings were affected by the disruption of the foundation drains and, as at B771, the subsequent presence of a groundwater sink (at B371/374, represented by the backfilled basement and sub-basement) that then took time to become saturated with groundwater. Water levels appear to be stabilizing in 2007. Water levels in wells 37105 (upgradient and west of the complex), 37705 (downgradient and east), and P114389 (at the north end of FC-1) were least affected by this behavior, and their hydrographs show relatively unimpacted water levels. (Note that well 37705 is separated from its predecessor, well 37701, by nearly 200 feet, as well as a difference in ground surface elevation of over 30 feet. This well is now situated at the convergence of the foundation drains, unlike the original well. As such, even though the hydrograph does not appear to show a significant discontinuity, these differences should be kept in mind when evaluating the associated data.) Conversely, the hydrographs for wells 37405 and 37505 show a sharp drop in water levels as the groundwater began to saturate the backfill within the building remnants; water levels appear to be stabilizing and show more seasonal influences in 2007. However, it also appears that these water levels are stabilizing at elevations that are somewhat below pre-closure levels—perhaps 10 feet lower at well 37405 and half that at 37505, although additional data are needed to confirm the differences. Water levels in the other wells are closer to or within their pre-closure ranges. In summary, water levels for wells closest to former B371/374 were strongly affected by closure activities, but are stabilizing and becoming more seasonally variable in 2007.

Wells that monitor along FC-2 include (listed in order from the head of the drainage to its confluence with North Walnut Creek) 33905, 21605, 21505, 21305, 21002, 20902, 52505, and 42505. Wells 20902 and 21002 are discussed above with B771, and well 33905 is discussed below with the VC Plume. The hydrographs for wells 21305 and 21505 both appear strongly affected by closure. The former rebounded little in 2006, but much more in 2007. Well 21505 rebounded immediately following closure; its hydrograph displays similar seasonality for both 2006 and 2007. Well 21605, located close to a seep northwest of former B559, appears less affected by closure than by the dry year of 2006; this is followed by a strong seasonal rebound in 2007. Well 52505, located closest to the creek feeding the FC-2 constructed wetland, is represented by a hydrograph that displays a general decrease in water levels at closure followed by a steady rebound extending through 2007. Water levels here appear more variable than in the pre-closure era, most likely reflecting the elimination of continuous surface-water contributions from the B371/374 foundation drain system, imported water, and runoff from impermeable surfaces. The effects of fourth-quarter sampling are also evident on the hydrograph for well 52505. Well 42505, located at the confluence of FC-2 and North Walnut Creek/FC-3, shows little seasonal influence following its post-closure rebound in early 2006, although the mid-2007 water level is the highest on record at this well. The difference in the hydrographs for wells 52505 (near the inlet of the FC-2 constructed wetland) and 42505 (at the outlet of this wetland) shows the effects of the retained water in FC-2, which acts to maintain a very uniform water level in downgradient well 42505 but has minimal or no effect on water levels in well 52505. In summary, wells located along FC-2 are represented by hydrographs that display strong seasonal recharge in 2007 and, in many cases, a return to more normal water levels following closure and the dry year of 2006. Wells within the drainage appear less strongly affected by the dry conditions of 2006, and at the confluence of FC-2 and North Walnut Creek groundwater levels have been steady since shortly after closure.

Wells 33502, 33604, 33703, and 33905 monitor the buried drainage that hosts the VC Plume upgradient of FC-2. Hydrographs for these wells show more pre-closure variation from one to the other than might be expected, given their close proximity to one another, but in the post-closure era, particularly in 2007, are fairly similar. All show a seasonal recharge in spring 2007 followed by a decline toward year end, and water levels in spring 2007 are the highest on record at each well. The two upgradient wells (33502 and 33604) show less impact from the dry conditions of 2006 than the two downgradient wells, but the more uniform responses to the 2007 recharge may be an indication that longer-term hydrograph patterns will be more similar among these four wells.

The former central IA is monitored by wells P114689, P115589, 56305, 55905, and 70705. Hydrographs for these wells show strong similarities in 2007. Spring water levels in well P114689 were slightly higher than historic levels, and the general trend appears to be toward a slightly higher water elevation. Conversely, although spring 2007 water levels in well P115589 are only slightly lower than historic values, the longer-term trend for groundwater elevations in this well appears to be toward a small decrease in average water levels. Wells 56305 and 55905 monitor former B559, and display very similar patterns. In 2007 these wells both show seasonal variations, and demonstrate increasing (higher) water levels that are more apparent at well 56305. Farther east, well 70705 also shows an increase in 2007 water levels that continues the trend of higher water levels begun in 2005 or early 2006. This increase may be related to the disruption of the foundation drain system supporting former B707, as that system would have acted to lower water levels in the area of this well prior to closure of the building. In general, wells in the former central IA displayed similar patterns in 2007, and with the removal of paved surfaces and infrastructure during Site closure, water levels at most locations appear to be stabilizing at slightly higher average levels than pre-closure values.

The former 400 and 600 Areas, located in the southern portion of the former IA and including former B444, is monitored by wells 40005, 40205, 40305, P419689, P416889, and 11502, plus to some degree well P416589. Hydrographs for the wells in this area show similar patterns in

2006 and 2007. All show lower water levels in 2006 as a result of the dry conditions that year, followed by a spring 2007 rebound. This pattern is minimized at well 40205, in keeping with the remarkably uniform water levels measured in this well since 2000 (with the exception of one reading in 2003 that was unusually high). The hydrographs for wells P419689 and P416889 are especially similar in their post-closure patterns. Wells in this area appear to be less affected by closure activities and more seasonally influenced in 2007 than previous years.

Wells monitoring the former B881 area include 39605, 88205, 88104, and 00797. The hydrographs for these wells do not show a high degree of similarity. In general terms, water levels in the wells closest to the former building—39605 on the west, 88104 and 88205 on the south—appear to have stabilized or nearly stabilized following the effects of closure. Well 39605 is deeper than its typically dry predecessor (which was strongly affected by the nearby foundation drain for B881), and therefore provides more complete water level data over its seasonal range. Post-closure groundwater elevations at this location may be somewhat higher than in the pre-closure era, but that is not yet certain. Water levels in both 88104 and 88205, located immediately south of the building, appear to be leveling off following a lengthy period in which the groundwater elevation gradually rose as the backfill within former B881 became saturated (a pattern not affecting well 39605 due to its upgradient/side-gradient location). As noted previously, it is important to bear in mind that the predecessor well for 88104 (88102) was approximately 110 feet north of the current well, which may alone be responsible for some of the variation seen in pre- versus post-closure groundwater elevations. Aside from the effects of sampling, an example of which is evident in the water level measured following the sampling event of May 2007, water levels in this well appear to be stabilizing at a much more uniform elevation (i.e., water levels do not vary as dramatically as in the pre-closure era) that may be somewhat lower than the average water level prior to closure. Conversely, the predecessor for well 88205 (well 5187) was less than 2 feet away, but water levels were kept artificially low by the building's foundation drain system and the underground tank adjacent to the original well. As a result, water levels in well 88205 are stabilizing approximately 20 feet above the pre-closure elevations. The hydrograph for well 00797, located farther south of former B881, shows relatively stable water levels affected by seasonal variations and sampling.

Water levels in the southeastern portion of the former IA are monitored by wells 22996, 37591, and 37691. Water levels in all three wells show strong seasonal (spring) recharge in 2007. The hydrograph for well 22996, located adjacent to former B886, is very similar in 2007 to prior years. Conversely, the hydrograph for well 37591, located near former B891, shows a drop in water elevation in fourth quarter CY 2007 that is the lowest water level indicated, although this well is not represented by many data points. Well 37691, located south of the former 904 Pad, has a pre-closure record dominated by dry conditions. In 2007, water was present in this well for the first time since shortly after the blizzard of 2003; however, the well was again dry by fourth quarter CY 2007.

Wells monitoring the Solar Evaporation Ponds (SEPs) and associated SPP include 00203 south of the SEPs; P210189 on the south edge of Pond 207-C; 79102, 79202, P208989, and 79302 along the northern edge of the former SEPs; 79402, 79605, and 79502 along the eastern edge of the SEPs; 22205 and P210089 near the base of the slope north of the SEPs; and 70099 and 70299 at the northwest edge of the SPPTS groundwater intercept trench. (Other wells in the North Walnut Creek drainage could also be considered here, but instead are discussed separately under the paragraph below on groundwater elevations within the drainage itself.) Hydrographs for the wells along the northern edge of the pediment (which coincides with the northern edge of the former SEPs), in particular those for wells 79102, 79202, and 79302, display fairly stable water levels with a very subtle spring 2007 recharge effect; a similar pattern is seen on the hydrograph for well 22205, located farther down the northern slope. This pattern is probably related to the generally wetter conditions that often exist along parts of this northern slope, as reflected in seasonal seeps. Hydrographs for wells on the pediment surface (such as wells P210189, 79402, 79502, and 79605) show greater water level fluctuations in response to seasonal recharge patterns, reflecting the typical hydrologic behavior of pediments at Rocky Flats, which gradually dewater as they act as a source of groundwater recharge to the hillslopes. Farther down in the valley, the hydrograph for well P210089 (just upgradient of the SPPTS) shows strong seasonal behavior as well as a rising water level since construction of nearby FC-3 and removal of the culverts that previously prevented runoff from recharging localized areas of this valley bottom, including in the vicinity of this well. Water levels in wells 70099 (screens alluvium) and 70299 (screens weathered bedrock) are relatively stable, and are affected by the SPPTS groundwater intercept trench a few feet to the south and the FC-3/North Walnut Creek a few feet to the north. In summary, groundwater elevations on the SEP pediment top typically show more marked seasonal behavior than do those along the north-facing SEP/SPP hillslope. Those nearer the valley bottom may show strong seasonal effects unless other controls outweigh these climatic factors.

Wells monitoring the North Walnut Creek drainage include, from upgradient to downgradient, P114389 in FC-1; 52505 and 42505 in the FC-2 constructed wetland area; 30002 on the south-facing slope, across from former B771/774; 70099 and 70299 (discussed above); 1786 and B210489 near the SPPTS DG; 51605 near the inlet to Pond A-1; 10594 in the Pond A-1 spillway; and well 41691 at the Walnut Creek/Indiana Street intersection. As noted above, wells P114389 and 42505 display fairly flat hydrographs, while that for 52505 clearly demonstrates seasonal variability and impacts from sampling. Hydrographs for the other wells farther east in this drainage display strong seasonal character, most classically displayed on the hydrograph for well 30002, with peaks in spring months and decreasing water levels during the summer through winter months. This well is mainly influenced by groundwater discharge from the pediment to the north and the occasional flow through the small drainage that was previously a borrow ditch along the north side of the North Perimeter Road. Of interest on the hydrograph for well 1786 is the general decline in water levels since closure that reflect the elimination of imported water and decrease in runoff-related recharge. The hydrograph for well 51605 is marked by its very low water levels in 2005 (as water slowly charged the well following its installation) and 2006 (a drier year). The groundwater elevation in this well appears to be stabilizing within the same range as pre-closure values. Water levels in well 10594 clearly show the effects of dry years (e.g., 2002 and 2006), when the well may go dry. Boundary well 41691 continues to be most strongly influenced by terminal pond discharges; as none were performed in 2006 and it was a dry year, the period of the lowest water elevations shown on the hydrograph are for water year 2006 (October 2005 through September 2006). The pond discharges in 2007 recharged the well, but by late 2007 this effect was diminishing. In summary, wells in the North Walnut Creek drainage are predominantly affected by seasonal climate patterns, with other localized factors also playing a part.

Contrary to the overall similarity in hydrographs for North Walnut Creek wells, those for wells monitoring the South Walnut Creek drainage show similarity based more on setting. This drainage is monitored by, from upgradient to downgradient, wells 99405 and 91305 near the

FC-4 constructed wetland, 23296 between Ponds B-2 and B-3, TH046992 in the Pond B-3 dam, 00997 near the inlet to Pond B-5, and 41691 at Walnut Creek and Indiana Street. (Wells positioned along the ETPTS intercept trench are not included in this discussion, and well 41691 is discussed above.) The hydrographs for wells 91305, 23296, and TH046992 appear most similar and are relatively uniform, with minor seasonal fluctuation in water levels; this similarity could be attributed to the fact that they are all adjacent to ponds or saturated areas. However, well 99405 and, to some extent, well 00997 are also located very near such areas, yet hydrographs for these wells show greater variability in water levels that is only partially explained by seasonal influences. The variability seen on the hydrograph for well 99405 can be attributed to sampling events. That for well 00997 can be explained by the strong effects of the dry 2006, elimination of imported water that previously filled Pond B-5, and the fewer discharges that have been conducted since closure. As might be expected, the loss of imported water appears to be resulting in an average water level in well 00997 that is stabilizing at an elevation that is lower than was the case prior to closure, similar to conditions at Boundary well 41691. However, the opposite appears to be true for wells 23296 and 91305, while average water levels are unchanged at well TH046992 and are unclear at well 99405.

The Woman Creek drainage is monitored by, from upgradient to downgradient, wells 80005, 80105, 80205, 11104, 89104, 10304, 00193, and 10394. Except for 10394, which is located at the Woman Creek/Indiana Street intersection, these wells are all represented by relatively few data, making it difficult to determine clear patterns in groundwater levels. Wells 80005, 80105, and 80205 are all located below the OLF and are represented by hydrographs that display a pattern that is interesting as a whole. Wells 80005 and 80205 are each positioned adjacent to the OLF diversion channels and are at the west and east ends, respectively, of the clay buttress at the base of the OLF. Conversely, well 80105 is located between the channels and closer to the midpoint of the buttress. The hydrographs for the wells on the ends show a seasonal influence, while that in the middle shows an inverted seasonal pattern—lower water levels in spring, and higher water levels in the fall and winter—that is exactly opposite the pattern in wells 80005 and 80205. This is likely due to a combination of factors including nearby Woman Creek, the perimeter ditches, and interception and storage of groundwater from the OLF hillside within the buttress. Note that well 80205 is located adjacent to OLF Seep #8, yet does not appear to reflect the higher water levels that would result if the well monitored the same water that issues at the seep. Farther downgradient, wells 11104 (just east of the OLF wells) and 10304 (immediately east of Pond C-1) show seasonal patterns that are similar to, but slightly more pronounced than, those shown by OLF wells 80005 and 80205. Well 89104, located between wells 11104 and 10304, is represented by a hydrograph that does not resemble any others in this drainage. Instead, water levels in this well steadily increased through 2006, apparently stabilizing in 2007 at a relatively uniform, slightly seasonally influenced elevation. Well 00193, located near the Pond C-2 inlet, appears to reflect seasonally influenced water levels combined with impacts from sampling in 2007. Water levels in Boundary well 10394 show a very uniform seasonal pattern that included annual dry periods prior to 2004, but since that year it appears the well has retained water year-round.

### *Groundwater Flow Velocities*

Groundwater flow directions and velocities in 2007 are generally consistent with those reported in 2006. Flow directions, water level data, geological information, and completed well designs and locations support the selection of several well pairs for the calculation of linear groundwater flow velocities, also referred to as seepage velocities. Using the potentiometric surface maps, a pair of wells is potentially useful if a line drawn between them is perpendicular (or nearly so) to the potentiometric contour lines between the two wells, and there are no intervening drainages or artificial groundwater control structures (such as the groundwater intercept trenches that are a component of each of the treatment systems, and the GWIS at the PLF).

Well pairs selected for use in this report are the same as those selected in 2006 with one change: well 90299 was used instead of 90399 as the downgradient pairing to well 00491 in order to better reflect the flow direction indicated by the potentiometric surface map.

The seepage velocity (*v*) may be calculated using the Darcy equation:

$$v = \left(K/n\right)\left(dh/dl\right)$$

where

$K$ = hydraulic conductivity
$n$ = effective porosity
$dh/dl$ = hydraulic gradient.

This calculation is most sensitive to the hydraulic gradient and value of K used, because for all calculations of *v* in this report a porosity of 0.1 (consistent with previous Annual RFCA Groundwater Monitoring Reports) is used.

The hydraulic gradient was calculated from groundwater elevation data collected in the second and fourth quarters of 2007. Results of this calculation typically differ slightly when using data from one quarter versus that from another, but the differences are typically not large.

Calculated seepage velocities are only useful as estimates. These velocities are most often used to estimate the travel time of conservative (nonreactive) constituents. Reactive constituents will tend to migrate more slowly than the calculated velocity. These calculated velocities do not take into account properties such as sorption and chemical reactions (e.g., precipitation, biodegradation, and volatilization) that can strongly influence the migration rate of groundwater contaminants.

For each well pair, the value of K selected for this calculation was based on the predominant lithologic unit comprising the flow path between the two wells. This is based on the core logs for the respective wells and the published geology (EG&G 1995b), as well as information from the hydrographs (i.e., whether the saturated interval is typically restricted to the bedrock or includes surficial materials). If more than one lithology is represented between the wells and, from the hydrographs, appears to comprise a meaningful fraction of the saturated interval, an average K was calculated from the lithologies. K values used for these calculations are from EG&G (1995a), Table G-2, with subsequently modified values for Rocky Flats Alluvium and valley-fill alluvium (RMRS 2000; Safe Sites 2001, 2002).

One factor that may cause significant error in estimated seepage velocities is the presence of artificial fill in many portions of the former IA. The K for Rocky Flats Alluvium is used because the source of the fill was typically deposits of Rocky Flats Alluvium. However, it is unlikely that the backfilled alluvium has the internal structure or is as compacted as the original deposits, resulting in a higher effective porosity and K than the published values for Rocky Flats Alluvium. Where well pairs cross former buildings that were backfilled with concrete rubble and alluvium, the effective porosity and K values will be higher still. For this report, well pairs crossing areas of sufficiently thick backfill deposits may use the K for Rocky Flats Alluvium rather than that for the original lithology, under the assumption that the entire area of backfill/regrading has a hydraulic conductivity closer to that of Rocky Flats Alluvium than to a lower-permeability unit.

An example well pair may serve to illustrate some of the related difficulties. Well 18199 is located between former B776 and B771. It screens Rocky Flats Alluvium and sandstone of the Arapahoe Formation (the “No. 1 Sandstone;” EG&G 1995a). Groundwater in this area previously flowed toward the west as a result of the B771 foundation drain system. Following disruption of this drain, groundwater flow is anticipated to be more northerly, potentially through the rubble- and alluvium-backfilled subsurface remnants of B771. Well 20505 was selected as the downgradient well in this well pair. This well screens artificial fill, clays, claystone, and silty claystone. The transect from 18199 to 20505 is mostly occupied by the artificial fill of the B771 closure, and that fill is essentially reworked alluvium. Therefore, an average hydraulic conductivity of the Arapahoe Formation No. 1 Sandstone and Rocky Flats Alluvium is used to calculate the seepage velocity between this well pair.

As noted above, these calculated velocities are based in part on data displayed on the hydrographs: where water is shown above the bedrock contact, hydraulic conductivities for the unconsolidated surficial material (e.g., Rocky Flats Alluvium or colluvium) are included for this calculation. If the hydrographs show water is typically restricted to the bedrock, the K value for the generalized bedrock type at that well is selected. Note that, similar to the alluvial deposits, the extreme variability of bedrock lithologies (e.g., from claystone to silty claystone to clayey siltstone to siltstone) is often reflected in cores from the screened interval of a given well, but a single K value is selected to represent the well.

Table 3-41 presents the results of the calculation of seepage velocities. Refer to Figure 3-202 for the respective locations of the wells. Estimated velocities range from 17 feet per year (ft/yr) (along the pediment surface from well 40305 to 39605 in the South IA area) to 585 ft/yr (on the hillslope from well 18199 to 20505 in the B771 area). The resulting travel time between each well in a well pair ranges from approximately 1onths (from well 18199 to 20505) to over 72 years (from well 40305 at B444 to well 22996 at B886). These velocities are comparable to those calculated prior to Site closure (e.g., K-H 2004b), and are also similar to those discussed in 2006. For a more detailed discussion of flow between well pairs by area, refer to the 2006 Annual Report. (Note that in two cases—40399 to 22996 and 00491 to 90299—a member of the well pair was dry in the fourth quarter, preventing calculation of the velocity.)

*Table 3-41. Calculated Flow Velocities for 2007*

| Well Pair | Area | 2007 Quarter | Geological Unit | WL Elevation, Well 1 | WL Elevation, Well 2 | dh (ft) | dl (ft) | dh/dl (hydraulic gradient) | K (cm/s) | v (ft/yr) | Time to Traverse Transect (yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| P115589-P114689 | North IA | 2 | Qrf | 6010.02 | 6000.52 | 9.5 | 550.14 | 0.017 | 4.18E-04 | 74.68 | 7.37 |
| P115589-P114689 | North IA | 4 | Qrf | 6004.55 | 5994.88 | 9.67 | 550.14 | 0.018 | 4.18E-04 | 76.02 | 7.24 |
| P114689-56305 | North IA/ 559 | 2 | Qrf | 6000.52 | 5990.86 | 9.66 | 304.74 | 0.032 | 4.18E-04 | 137.09 | 2.22 |
| P114689-56305 | North IA/ 559 | 4 | Qrf | 5994.88 | 5986.93 | 7.95 | 304.74 | 0.026 | 4.18E-04 | 112.82 | 2.70 |
| 56305-21605 | B559 | 2 | Qrf/Qc | 5990.86 | 5968.91 | 21.95 | 319.61 | 0.069 | 2.56E-04 | 181.66 | 1.76 |
| 56305-21605 | B559 | 4 | Qrf/Qc | 5986.93 | 5965.14 | 21.79 | 319.61 | 0.068 | 2.56E-04 | 180.33 | 1.77 |
| 18199-20505 | B771 | 2 | Qrf/ KaNo.1ss | 5976.5 | 5929.58 | 46.92 | 500.43 | 0.094 | 6.03E-04 | 584.96 | 0.86 |
| 18199-20505 | B771 | 4 | Qrf/ KaNo.1ss | 5973.18 | 5931.93 | 41.25 | 500.43 | 0.082 | 6.03E-04 | 514.27 | 0.97 |
| P416589-80105 | OLF | 2 | Qrf/KaKlclst | 6016.82 | 5936.86 | 79.96 | 846.63 | 0.094 | 2.09E-04 | 204.66 | 4.14 |
| P416589-80105 | OLF | 4 | Qrf/KaKlclst | 6012.36 | 5940.56 | 71.8 | 846.63 | 0.085 | 2.09E-04 | 183.39 | 4.62 |
| 40305-39605 | South IA | 2 | Qrf/KaKlslt | 6008.03 | 5997.14 | 10.89 | 1126.39 | 0.010 | 2.23E-04 | 22.35 | 50.41 |
| 40305-39605 | South IA | 4 | Qrf/KaKlslt | 6004.05 | 5995.72 | 8.33 | 1126.39 | 0.007 | 2.23E-04 | 17.09 | 65.90 |
| 40005-P419689 | South IA | 2 | Qrf | 6008.79 | 6005 | 3.79 | 478.87 | 0.008 | 4.18E-04 | 34.23 | 13.99 |
| 40005-P419689 | South IA | 4 | Qrf | 6006.36 | 6001.74 | 4.62 | 478.87 | 0.010 | 4.18E-04 | 41.72 | 11.48 |
| P419689-11502 | South IA | 2 | Qrf | 6005 | 6001.05 | 3.95 | 535.27 | 0.007 | 4.18E-04 | 31.91 | 16.77 |
| P419689-11502 | South IA | 4 | Qrf | 6001.74 | 5997.72 | 4.02 | 535.27 | 0.008 | 4.18E-04 | 32.48 | 16.48 |
| 40305-22996 | South IA/ 800 Area | 2 | Qrf/KaKlclst* | 6008.03 | 5981.6 | 26.43 | 2037.05 | 0.013 | 2.09E-04 | 28.12 | 72.45 |
| 40305-22996 | South IA/ 800 Area | 4 | Qrf/KaKlclst* | 6004.05 | Dry | N/A | 2037.05 | N/A | N/A | N/A | N/A |
| 88205-00797 | 881 Hillside | 2 | Qrf/Qc | 5971.05 | 5923.87 | 47.18 | 343.12 | 0.138 | 2.56E-04 | 363.70 | 0.94 |
| 88205-00797 | 881 Hillside | 4 | Qrf/Qc | 5969.1 | 5923.18 | 45.92 | 343.12 | 0.134 | 2.56E-04 | 353.99 | 0.97 |
| 00191-00491 | 903 Pad-Lip | 2 | Qrf/KaKlclst | 5952.8 | 5891.88 | 60.92 | 816.98 | 0.075 | 2.09E-04 | 161.58 | 5.06 |
| 00191-00491 | 903 Pad-Lip | 4 | Qrf/KaKlclst | 5949.41 | 5889.22 | 60.19 | 816.98 | 0.074 | 2.09E-04 | 159.65 | 5.12 |
| 00491-90299 | 903 Hillside | 2 | Qc/KaKlclst | 5891.88 | 5812.02 | 79.86 | 609.84 | 0.131 | 4.71E-05 | 63.80 | 9.56 |
| 00491-90299 | 903 Hillside | 4 | Qc/KaKlclst | 5889.22 | Dry | N/A | 609.84 | N/A | N/A | N/A | N/A |
| 07391-10304 | Ryan's Pit/ Woman Creek | 2 | Qc/KaKlclst | 5943.54 | 5811.01 | 132.53 | 948.74 | 0.140 | 4.71E-05 | 68.06 | 13.94 |
| 07391-10304 | Ryan's Pit/ Woman Creek | 4 | Qc/KaKlclst | 5941.75 | 5809.74 | 132.01 | 948.74 | 0.139 | 4.71E-05 | 67.79 | 13.99 |
| 91105-91203 | OBP #2 | 2 | Qrf/KaKlslt | 5948.04 | 5934.44 | 13.6 | 242.17 | 0.056 | 2.23E-04 | 129.81 | 1.87 |
| 91105-91203 | OBP #2 | 4 | Qrf/KaKlslt | 5946.67 | 5933.52 | 13.15 | 242.17 | 0.054 | 2.23E-04 | 125.51 | 1.93 |
| 91105-15499 | OBP #2 | 2 | Qrf/Qc | 5948.04 | 5921.25 | 26.79 | 392.19 | 0.068 | 2.56E-04 | 180.68 | 2.17 |
| 91105-15499 | OBP #2 | 4 | Qrf/Qc | 5946.67 | 5920.69 | 25.98 | 392.19 | 0.066 | 2.56E-04 | 175.22 | 2.24 |

*Table 3−41 (continued). Calculated Flow Velocities for 2007*

| Well Pair | Area | 2007 Quarter | Geological Unit | WL Elevation, Well 1 | WL Elevation, Well 2 | dh (ft) | dl (ft) | dh/dl (hydraulic gradient) | K (cm/s) | v (ft/yr) | Time to Traverse Transect (yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 91105-15399 | OBP #2 | 2 | Qrf/Qc | 5948.04 | 5925.36 | 22.68 | 394.09 | 0.058 | 2.56E-04 | 152.22 | 2.59 |
| 91105-15399 | OBP #2 | 4 | Qrf/Qc | 5946.67 | 5924.95 | 21.72 | 394.09 | 0.055 | 2.56E-04 | 145.78 | 2.70 |
| 00897-15499 | Mound | 2 | KaKlslt/Qc | 5943.67 | 5921.25 | 22.42 | 366.17 | 0.061 | 6.11E-05 | 38.67 | 9.47 |
| 00897-15499 | Mound | 4 | KaKlslt/Qc | 5943.63 | 5920.69 | 22.94 | 366.17 | 0.063 | 6.11E-05 | 39.57 | 9.25 |
| 00897-15399 | Mound | 2 | KaKlslt/Qc | 5943.67 | 5925.36 | 18.31 | 347.49 | 0.053 | 6.11E-05 | 33.28 | 10.44 |
| 00897-15399 | Mound | 4 | KaKlslt/Qc | 5943.63 | 5924.95 | 18.68 | 347.49 | 0.054 | 6.11E-05 | 33.96 | 10.23 |
| P210189-79102 | SEPs | 2 | KaKlslt/Qrf | 5970.07 | 5948.99 | 21.08 | 301.98 | 0.070 | 2.23E-04 | 161.35 | 1.87 |
| P210189-79102 | SEPs | 4 | KaKlslt/Qrf | 5967.44 | 5948.28 | 19.16 | 301.98 | 0.063 | 2.23E-04 | 146.65 | 2.06 |
| 79102-22205 | North of SEPs | 2 | KaKlslt | 5948.99 | 5915.35 | 33.64 | 235.62 | 0.143 | 2.88E-05 | 42.54 | 5.54 |
| 79102-22205 | North of SEPs | 4 | KaKlslt | 5948.28 | 5916.5 | 31.78 | 235.62 | 0.135 | 2.88E-05 | 40.19 | 5.86 |
| 79502-99305 | SEPs/B991 | 2 | KaKlslt/Qrf | 5962.75 | 5929.78 | 32.97 | 532.37 | 0.062 | 2.23E-04 | 143.15 | 3.72 |
| 79502-99305 | SEPs/B991 | 4 | KaKlslt/Qrf | 5960.78 | 5929.62 | 31.16 | 532.37 | 0.059 | 2.23E-04 | 135.29 | 3.94 |
| 70393-70693 | PU&D/PLF | 2 | Qrf | 5993.32 | 5979.67 | 13.65 | 410.48 | 0.033 | 4.18E-04 | 143.82 | 2.85 |
| 70393-70693 | PU&D/PLF | 4 | Qrf | 5986.3 | 5973.05 | 13.25 | 410.48 | 0.032 | 4.18E-04 | 139.60 | 2.94 |
| 30900-30002 | PU&D/ North Walnut Creek | 2 | Qrf/KaKlclst | 6000.45 | 5926.28 | 74.17 | 1890.74 | 0.039 | 2.09E-04 | 85.01 | 22.24 |
| 30900-30002 | PU&D/ North Walnut Creek | 4 | Qrf/KaKlclst | 5992.7 | 5922.16 | 70.54 | 1890.74 | 0.037 | 2.09E-04 | 80.85 | 23.39 |

Notes: WL = water level; dh (ft) = difference in height, in feet; dl (ft) = distance between wells, in feet; cm/s = centimeters per second; v (ft/yr) = velocity in feet per year; yr = years.
Qrf = Rocky Flats Alluvium; Qc = colluvium; KaNo.1ss = Arapahoe Formation No. 1 Sandstone; KaKlclst = undifferentiated Arapahoe/Laramie Formation claystone; KaKlslt = undifferentiated Arapahoe/Laramie Formation siltstone.
*Bedrock lithology estimated due to incomplete core log for well 22996.

In the one case where a well pairing changed from 2006 (current well pair 00491 to 90299, mentioned above), calculated flow velocities increased from approximately 49 ft/yr using the previous pairing to approximately 64 ft/yr. This change was made because 00491-90299 reflects a more viable flow path (more nearly perpendicular to potentiometric contours) than the previous pairing.

Few Evaluation wells were sampled in 2007, and therefore new information regarding contaminant transport was limited in most source areas. The few well pairs sampled in 2007 are discussed in Section 3.1.5.2, and of these only one well pair (discussed first) appears to present noteworthy results.

One well pair in the Ryan’s Pit Plume for which velocities and travel times were calculated (Evaluation well 07391 to AOC well 10304) was sampled in 2007, with well 10304 showing a detection of TCE. As previously noted, more data are required before it can be reasonably concluded that this detection is or is not related to groundwater from Ryan's Pit.

In the Individual Hazardous Substance Site (IHSS) 118.1 area, data from well 20505 (downgradient from source-area well 18199) continued to show no detections of carbon tetrachloride or chloroform, the most notable contaminants from IHSS 118. Seepage velocities summarized in Table 3-41 indicate that these contaminants could have been detected in well 20505 beginning in 2006, but this has still not occurred. This may be evidence of contaminant retardation, or it could indicate that groundwater is being diverted in another direction or that these constituents are being degraded before they reach the receptor well(s). While the flow path from 18199 to 20505 appears reasonable, groundwater may be diverted by the presence of disrupted foundation drains and associated corridors, the backfilled B771, and backfilled/ disrupted subsurface utility corridors around the sides of the building.

In the former SEP area, travel times for a potential southeastern route for nitrate contamination were calculated to be slightly less than 4 years, using the 79505-99305 well pairing. The continued absence of significant nitrate contamination in groundwater samples from well 99305 (the results in 2007 included one nondetect and one detection reported at 0.34 mg/L) indicates that the potential flow path from 79502 to 99305 may represent a negligible transport mechanism for the SPP.

Overall, groundwater flow paths and flow velocities in 2007 show little change from 2006.

### 3.1.4 Surface-Water Data Interpretation and Evaluation

#### 3.1.4.1 Surface Water-Quality Summaries

This section presents water-quality summaries for select analytes for the period January 1, 1997, through December 31, 2007 (CY 1997–2007), for the locations operational in CY 2007. Radionuclides summarized include Pu, Am,[18] and total U. Additionally, the POE metals (total beryllium [Be], dissolved cadmium [Cd], total chromium [Cr], and dissolved silver [Ag]) are also summarized. Additional analyses are also performed based on the specific monitoring objective. The results and evaluation for these additional analytes are presented in Section 3.1.2.1 through Section 3.1.2.11 by monitoring objective.

***Radionuclides***

The following summaries include all results that were not rejected through the validation process.[19] Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations/activities and analytical error are often greater than the precision presented. When a negative radionuclide result (e.g., −0.002 pCi/L) is reported by the laboratory due to blank correction, a value of 0.0 pCi/L is used for calculation purposes. When a sample has a corresponding field duplicate, the value used

[18] In this report, "plutonium" or "Pu" refers to plutonium-239,240 and "americium" or "Am" refers to americium-241.
[19] Summaries do not include supplemental post-closure grab samples from GS13 that were collected to assess modifications to the SPPTS; only routine continuous flow-paced samples are included.